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# ANNALS
OF THE
# MISSOURI BOTANICAL GARDEN

# Annals
## of the
# Missouri Botanical Garden

Volume XXI
1934

With Eighteen Plates and Eighty-seven Figures

Published quarterly at Fulton, Missouri, by the Board of Trustees
of the Missouri Botanical Garden, St. Louis, Mo.

Entered as second-class matter at the post-office at Fulton, Missouri,
under the Act of March 3, 1879.

# Annals
of the
# Missouri Botanical Garden

A Quarterly Journal containing Scientific Contributions from the Missouri Botanical Garden and the Graduate Laboratory of the Henry Shaw School of Botany of Washington University in affiliation with the Missouri Botanical Garden.

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The ANNALS OF THE MISSOURI BOTANICAL GARDEN appears four times during the calendar year: February, April, September, and November. Four numbers constitute a volume.

Subscription Price........$6.00 per volume
*Single Numbers.......... 1.50 each*

Contents of previous issues of the ANNALS OF THE MISSOURI BOTANICAL GARDEN are listed in the Agricultural Index, published by the H. W. Wilson Co.

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## ERRATA

Pages 227–230. Change *ramosculis* to *ramusculis*, and *saliente* to *salienter*, throughout.

Page 423, line 4. For *diastase* read *invertase*.

Page 426, line 10. For *Haldans* read *Haldane*.

Annals
of the
Missouri Botanical Garden

VOL. 21 FEBRUARY, 1934 No. 1

# A REVISION OF THE NORTH AMERICAN SPECIES OF THE GENUS CHORIZANTHE[1]

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## HISTORY OF THE GENUS

When Bentham[2] treated the tribe Eriogoneae in 1836, three genera were considered, namely, *Eriogonum, Chorizanthe,* and the then-monotypic *Mucronea.* The latter two were described as new, *Chorizanthe* having been a manuscript name of Robert Brown. Eleven species of *Chorizanthe* were described at this time, seven from South America and four from North America. Bentham[3] also elaborated the genus for De Candolle's 'Prodromus,' eighteen species being considered there.

In 1870 Torrey and Gray[4] revised the North American members of the genus. It was in this paper that *Acanthogonum* was reduced to synonymy under *Chorizanthe,* and *Mucronea* had already suffered a similar fate at the hands of the junior author.[5] Torrey and Gray's revision appears in a condensed

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[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

[2] Benth. Trans. Linn. Soc. Lond. **17**: 401-420. *pl. 17-20.* 1836.

[3] Benth. in DC. Prodr. **14**: 24-27. 1857.

[4] Torr. & Gray, Proc. Am. Acad. **8**: 192-199. 1870.

[5] Gray, Proc. Bost. Soc. Nat. Hist. **7**: 149. 1859.

Issued April 12, 1934.

form in the appendix of Watson's[6] 'Botany of the United States Geological Exploration of the Fortieth Parallel.'

Numerous collections from the western states were accumulating in herbaria during this time, resulting in the discovery of many new species. In 1877 Watson[7] found it advisable to revise again the North American members of the genus, together with the other genera of the Eriogoneae. Twenty-five species were recognized in this revision, and *Centrostegia* Gray was relegated to *Chorizanthe.*

The last revision was made by Parry[8] in 1884, and Dammer's[9] brief treatment of the genus in Engler and Prantl's 'Natürlichen Pflanzenfamilien' is patterned in some part after Parry's work. Several desultory descriptions have appeared since Parry's revision, bringing the total number of described species for this country, including the six species from other genera which were united with *Chorizanthe,* to something over fifty.

Four related genera, *Mucronea* Benth., *Acanthogonum* Torr., *Centrostegia* Gray, and *Lastarriaea* Remy, have at various times been considered by some taxonomists as synonymous with *Chorizanthe.* The genus *Lastarriaea* is considered congeneric with *Chorizanthe* in the present work, and the other three genera are held to be distinct.

The genus *Hamaria* Kunze, Poepp. Coll. Chil. I, is cited by Reichenbach[10] in his 'Conspectus' as of the family Rosaceae. The leading subsequent bibliographic works in which *Hamaria* Kunze appears also have definitely or questionably referred the genus to the Rosaceae. However, Baillon[11] places the genus in the Polygonaceae, with *Lastarriaea* as its synonym. Some basis is found for this in an article by Parry[12] in which he states that a sheet of *Lastarriaea* at Kew is marked "50 Poppig, Pl. Chil. Hamaria Poppigii, Ky. . . . Paronychiaceae? . . .” With this evidence at hand, the name is listed in the generic synonymy.

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[6] Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484-485. 1871.

[7] Wats. Proc. Am. Acad. **12**: 269-273. 1877.

[8] Parry, Proc. Davenp. Acad. Sci. **4**: 45-63. 1884.

[9] Dammer in Engl. & Prantl, Nat. Pflanzenfam. $3^{1a}$: 11-12. 1891.

[10] Reichenb. Conspectus, 212b. 1828.

[11] Baillon, Hist. d. Pl. **11**: 397. 1892.

[12] Parry, West. Am. Sci. **1**: 29. 1885.

In Torrey and Gray’s revision, *Chorizanthe membranacea* Benth. is listed as the first species of section Euchorizanthe. Watson followed this precedent, while Parry chose *C. stellulata* Benth. as the first species in the group of typical Chorizanthes. However, *Chorizanthe virgata* Benth., a South American species, is listed first in Bentham’s original work, where it is both described and figured, so it must be accepted as the type species. There is a fortunate aspect to this change in that *C. virgata* is a typical *Chorizanthe* and *C. membranacea* is considered by the present writer as a member of a new genus.

The history of the South American members is brief. In addition to the species of Bentham, there are two by Remy[13] and sixteen by Philippi, five of the latter appearing in 1864-65,[14] one in 1873,[15] and the remainder in 1895.[16]

The tribe Eriogoneae is a very distinct one of the Polygonaceae. Meisner[17] gave the group of genera, *Pterostegia, Mucronea, Chorizanthe,* and *Eriogonum,* family rank. However, the floral structure, as well as other morphological characteristics, indicates the natural affinities of the genus with the Polygonaceae.

The additional amount of North American material of the genus which has accumulated in herbaria during the past few years allows a study to be much more comprehensive than heretofore, and makes such a study advisable.

## General Morphology

*Roots.*—All of the North American representatives of the genus are annuals, and the root system consists of but a slender tap-root with small lateral roots.

*Stems.*—The stems vary from erect to prostrate, and are from one to several from the base. They are dichotomously branched or, in some species, frequently trichotomously branched at the first node. The stems are from a half to five decimeters long, and nearly always slender and rather stiff. They vary from hirsute to glabrate.

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[13] Remy in Gay, Fl. Chili **5**: 287, 288. 1849.

[14] Philippi, Linnaea **33**: 225-227. 1864-1865.

[15] Philippi, Anal. Univ. Chili **1873**: 536. 1873.

[16] Philippi, *l. c.* **91**: 494-500. 1895.

[17] Meisn. Pl. Vasc. Gen. 1: 317; 2: 229. 1836-1843.

*Leaves.*—The leaves are always basal or nearly so, and entire. Commonly they are petiolate, oblanceolate, and obtuse, and two to ten centimeters long. In some of the species, the leaves may be scantily pubescent but usually they are tomentose or densely short-villous beneath and short-villous above. The leaves are very prone to fall from the mature plants.

*Bracts.*—The bracts are characteristically opposite, although the foliaceous bracts of some species, as *C. interposita, C. Douglasii,* and *C. stellulata,* are verticillate. The bracts subtending the involucres are regularly narrowly lanceolate-acerose and ciliate, and sometimes all the bracts are of this type, as is manifested by certain species in the subsections Staticoideae and Flavae. Very frequently the lower bracts are foliaceous and often simulate the leaves very closely. Opposite, oblanceolate, foliaceous bracts are characteristic of the subsection Pungentes.

*Pubescence.*—The pubescence is of unicellular white hairs, and the various species are prevailingly canescent with straight or curly, appressed or spreading hairs. The pubescence on the stems is often characteristic for a subsection—widely spreading hairs prevailing in the Pungentes, while an unusual type of pubescence is found on the stems of members of the subsection Staticoideae. Here the hairs are down-curved for a short distance, then abruptly appressed, giving them a hook-like appearance. Thicker, crystal-clear hairs are unique in *C. Wheeleri,* where they are found upon the involucres.

*Inflorescence.*—The inflorescence is always cymose, and the involucres are sessile in the axils. Most commonly the involucres are borne in clusters or dense heads, this structure being attained, of course, through the great foreshortening of the internodes. In some species, as *C. staticoides,* for example, this foreshortening takes place about equally, and at first gradually, on each branch of the cyme, making the whole inflorescence more or less flat-topped. Again, the foreshortening may occur very abruptly, resulting in a single dense head, as is often found in *C. stellulata*. One of the most common modifications of the inflorescence, however, has resulted in the development of a sort of uniparous cyme. Here but one branch develops in an elongate manner from each node, and the development occurs alternately at each successive node. The opposite, or foreshortened, branch from each node, instead of subtending only a flower, or bearing a flower, subtends one and bears several in a close cluster. For convenience, this type of inflorescence has been termed a compound uniparous cyme. It is prevalent in the Pungentes and Procumbentes.

*Involucres.*—The involucres, composed usually of six connate bracts, form a more or less tubular protective organ for the perianth. They are two to seven millimeters long, and six-toothed, except in the subsection Flavae, where the smaller three teeth are sometimes obsolete, and in some of the subsection Chorizanthella, where the number is three, or, in the unusual *C. Watsoni,* five.

The involucres are usually dimorphic. The few solitary ones in the lower axils are larger and less modified than the ultimate ones, and are thought to possess the characters of more or less immediate ancestors. They do not have characters suitable for taxonomic diagnosis. The involucres hereafter referred to are the typical ultimate ones.

Of the six-toothed involucres, three of the teeth, including the anterior one, are usually larger than the alternating trio, and are spoken of as the "outer" or "larger" teeth, while the alternating three are known as the "inner" or "smaller" teeth. The teeth are spine-pointed, and the spines are down-curved or uncinate except in a few species, as *C. Howellii, C. villosa,* and *C. valida.*

In many species, the anterior involucral tooth is detectably longer than any of the others. Inasmuch as this condition is found in the species whose involucres are in dense clusters, it is thought that perhaps the lack of pressure on the anterior tooth has permitted or caused its additional growth. This mechanical explanation alone would hardly account for the development of the very long spines of *C. Clevelandii* and *C. uniaristata.* Possibly the germ plasm of plants is affected by environmental stimuli, and the long anterior teeth of these last two species of the Uniaristatae now have a genetic cause—a theory which harkens back to Erasmus Darwin.

In one North American representative, *C. Lastarriaea* var. *californica*, the involucres are entirely lacking. This entity, commonly known heretofore as *Lastarriaea chilensis* Remy, has given rise to considerable discussion concerning its morphology. Authors prior to Parry had considered the structure which contained the reproductive organs as an involucre-like perianth. Parry,[18] in his revision, placed the species in *Chorizanthe*, stating that he had observed small structures in the so-called involucre-like perianth which represented a true, though vestigial, perianth, and hence the "involucre-like perianth" was a true involucre. Parry[19] maintains his position in a short article in the 'Western American Scientist.' The same year Mrs. Curran[20] criticised Parry's view, and stated: "As to the theory which has been advanced, that the perigonium of *Lastarriaea* is to be considered as an involucre, with adnate, nearly obsolete perianth, I can only say, that with some slight skill in the use of the microscope, I have been unable to find any trace of such organ" [p. 273]. Both were right, for the structures in question are present in some instances and quite lacking in others. Mrs. Curran was answered a little testily by Parry,[21] who still felt that he was correct. The next year, however, Parry[22] decided that Mrs. Curran was more nearly right than himself, and again recognized the genus *Lastarriaea*.

The present writer accepts, essentially, Parry's temporary disposition of *Lastarriaea* under *Chorizanthe*, but for very different reasons. The contention of Mrs. Curran, and earlier and subsequent workers, that the envelope surrounding the reproductive organs of the species in question was an involucre-like perianth is certainly correct. This involucre-like perianth is subtended by four or five bracts which are subverticillate but distinct—that is, they do not form a tubular involucre. A most interesting connecting link has been observed (described below as *C. interposita*) which possesses the more or less involucriform perianth plus a true involucre! The situation may be explained by referring to diagram *a* of fig. 1. Here two pairs of bracts of a typical *C. Lastarriaea* var. *californica* are indicated, and numbered 1 and 2, and 3 and 4. The position of the perianth is indicated by the triangle. In *C. interposita*, another pair of bracts is present (diagram *b* of fig. 1), numbered 5 and 6. Bracts 1, 2, and 3 are still distinct, as in fig. *a*, but bract number 4 and the pair of bracts 5 and 6 are united below, forming a true involucral tube of a three-toothed

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[18] Parry, Proc. Davenp. Acad. Sci. 4: 47. 1884.

[19] Parry, West. Am. Sci. 1: 29-31. 1885.

[20] Curran, Bull. Cal. Acad. Sci. 1: 272-275. 1885.

[21] Parry, Bot. Gaz. 11: 54-56. 1886.

[22] Parry, Proc. Davenp. Acad. Sci. 5: 35-36. 1887.

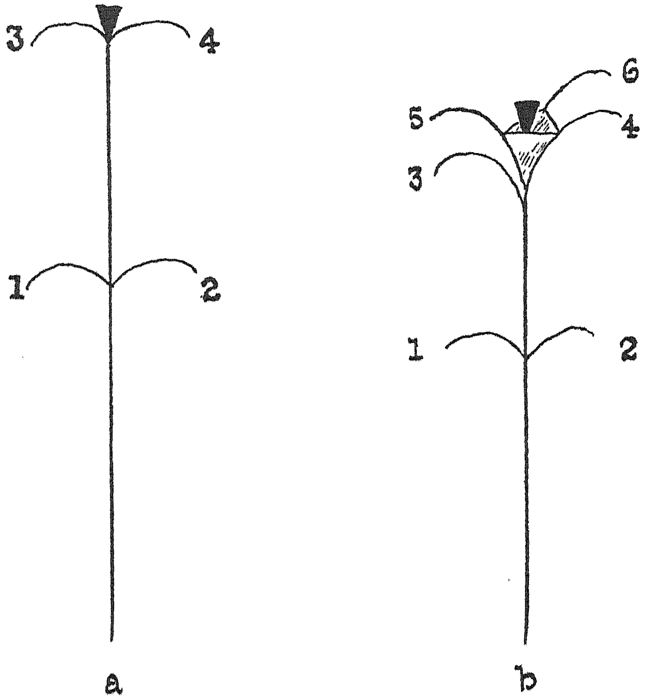

Fig. 1. Diagrammatic representation of the bracts subtending the perianths of (a) *C. Lastarriaea* var. *californica* and (b) *C. interposita*.

involucre. In the diagrams, the internodes have been elongated for the sake of clarity. *C. interposita* is quite inseparable morphologically from *Chorizanthe,* but it closely resembles *C. Lastarriaea* var. *californica.*

*Perianths.*—The perianths have as their most important character a tubular portion which constitutes at least half of the length of the flower. They are commonly sessile or nearly so, and subcylindric. The lobes or segments are six in number, or but five in the unusual *C. Lastarriaea* var. *californica.* The six lobes are in two whorls of three each, and are commonly sparsely pubescent along the midveins. The shape and relative size of the outer and inner whorls often characterize entire subsections. For instance, in subsections Chorizanthella, Pungentes, Flavae, and Procumbentes, the lobes are equal or subequal and usually entire. In the subsection Staticoideae, the lobes are prevailingly entire but the inner are smaller. In the subsection Uniaristatae, the outer lobes are entire or bilobed, and the inner smaller and fimbriate to erose.

*Stamens.*—The stamens are prevailingly nine in number, and the glabrous filaments are inserted at the base of the perianth. Occasionally the stamens are but six or three, but usually constant for the species. All but the first two species of the subsection Chorizanthella have the stamens inserted well up on the perianth tube, just below the lobes. An unusual development is manifested in the subsection Procumbentes, where the filaments are united into a short, pilose-ciliate, staminal tube. The anthers are orbicular to linear-oblong, versatile, and dehisce longitudinally on the lateral faces. The pollen is spherical, small, and smooth.

*Fruit.*—The fruit consists of a dry achene which is triangular in cross-section, elongated, and smooth or rarely papillose. The achenes are tri-carpellary and one-celled. The styles are three, and commonly at least half as long as the achene, and terminated by a small, capitate stigma. The ovule is solitary, basal, and orthotropous, containing at maturity abundant mealy endosperm and a straight or nearly straight embryo with essentially linear cotyledons.

## RELATIONSHIP OF THE GENUS, AND THE GENERIC CONCEPT

The genus *Chorizanthe* falls definitely in the tribe Eriogoneae of the Polygonaceae because of the prevailing presence of a more or less tubular involucre and the absence of ochreae. Of the genera of the tribe which possess tubular involucres, *Chorizanthe* is differentiated from all but two, *Acanthogonum* and *Eriogonella,* by the prevalence of but one flower in an involucre.[23] It is differentiated from all but *Acanthogonum* by the possession of a perianth tube, and from this latter genus it differs constantly in the shape of the embryo, and prevailingly in the six-toothed, rather than three-toothed, involucres, and the basal, rather than faucial, insertion of the stamens.

In delimiting the genera of this group which possess cup-shaped or tubular involucres, the condition of the perianth is considered to be of primary importance. This organ may be either parted or divided, or lobed. Whether the cotyledons are accumbent or straight is also of paramount importance. The morphology of the involucres, the lobing of the bracts, and the nature of the tomentum, are also significant in delimiting the genera concerned.

A glance at the accompanying diagram (fig. 2) will indicate the occurrence of two fundamental characters which have helped cause *Mucronea, Acanthogonum, Centrostegia,* and the new genus *Eriogonella* to be recognized generically in the present work. *Centrostegia,* for example, has long been united by taxonomists with *Chorizanthe,* but the parted perianth segments, the accumbent cotyledons, the glandular pubescence, and the three-cleft bracts, all show the genus to be much more closely related to *Oxytheca. Mucronea* has essentially the same characters except that involucral spurs are always lacking and the cotyledons are straight—thereby differentiating it from *Centrostegia* or *Oxytheca.* The former *Chorizanthe membranacea* and *Chorizanthe spinosa* each have parted perianth segments and accumbent cotyledons, definitely barring them from *Chorizanthe.* The entire bracts, the non-glandular pubescence, and the solitary flowers prevent them from being united to *Oxytheca* or *Centrostegia.* It is thought that their nearest relative is *Eriogonum.* From this large genus they

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[23] Parry reports two flowers in some specimens of *C. Orcuttiana,* and Greene says that there are "2 or more" in his *C. Nortoni.* The author has never seen but one flower in an involucre.

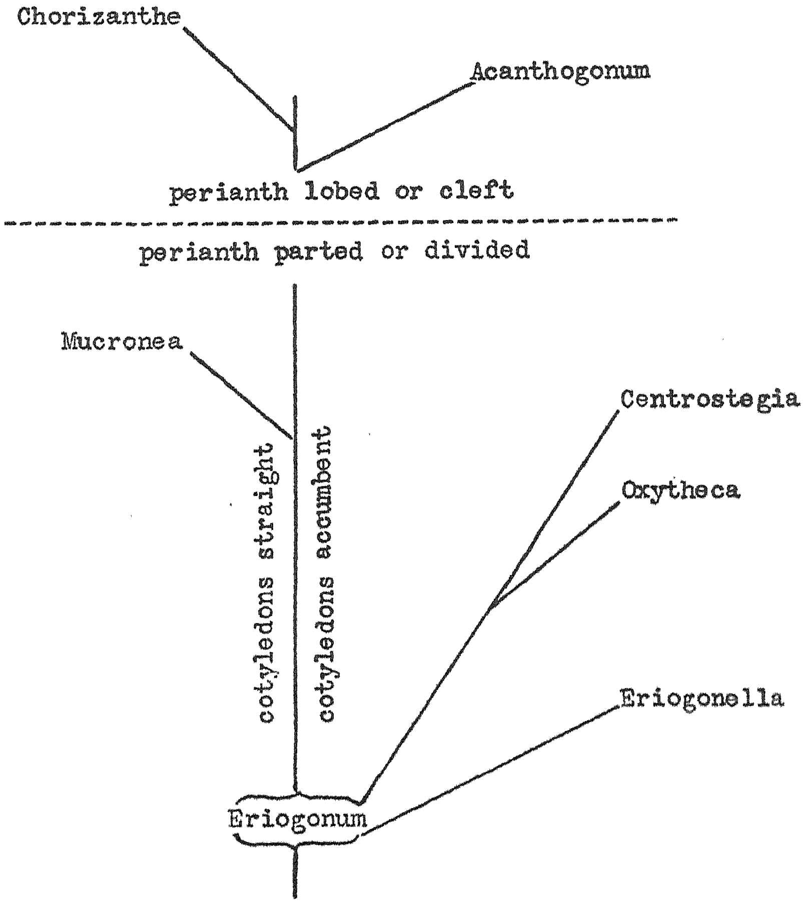

Fig. 2. Diagram to show relationships of seven related genera of the Eriogoneae.

are differentiated by the solitary flowers and spine-toothed involucres. The genus *Eriogonella,* to which these two species are referred, is formally characterized on page 90. These several smaller genera will be treated taxonomically in a subsequent paper.

Superficial resemblances can not be too greatly depended upon in this group because epiharmonic evolution has too often played a part. For example, the morphology of *Centrostegia* and *Oxytheca* is very similar, as already explained, yet *Centrostegia* has been referred to *Chorizanthe* on the basis, largely, of appearance. *Oxytheca perfoliata* and *Mucronea perfoliata* have developed very similar aspects, yet are certainly generically distinct. Perhaps it is the environment which has governed in part these similar developments, because certain southern California species of *Gilia* and *Nemacladus* simulate surprisingly annual members of the Eriogoneae.

While the detailed phylogeny of the tribe is reserved for the next paper on the Eriogoneae, it might be remarked here that a reduction series can be traced from many-flowered, fruticose forms (as in many Eriogonums) to few- or one-flowered annuals. An accurate phylogeny is thought to be more similar to that depicted by Gross[24] in his morphologic study of the Polygonaceae than the one outlined by Dammer.[25] Gross considers such genera as *Oxytheca, Centrostegia,* and *Chorizanthe* as derived from *Eriogonum,* whereas Dammer would reverse the sequence, with *Eriogonum* as the most "advanced" member.

## Phylogeny of the Species: the Subgeneric Categories

The South American perennial members of the genus possess several characters which, when compared with characters manifested by North American species, are accepted to-day by morphologists as being primitive. Some of the characters found in this South American group are, besides the perennial habit, the six subsimilar teeth of the involucres, which are short in comparison with the length of the involucral tube, the similar perianth lobes, and the nine stamens, which are attached below the middle of the perianth tube. In the North American species the annual habit is constant, and variations in the other characters are prevalent or frequent.

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[24] H. Gross in Engl. Bot. Jahrb. 49: 234-339. 1913.

[25] Dammer in Engl. & Prantl, Nat. Pflanzenfam. $3^{1a}$: 11-12. 1891.

A list of the significant characters are contrasted as follows:

| PRIMITIVE | ADVANCED |
|---|---|
| Perennial habit | Annual habit |
| Leaves cauline | Leaves basal |
| Involucral teeth subsimilar and short | Involucral teeth alternatingly long and short |
| Involucral teeth six | Involucral teeth five or three |
| Perianth lobes similar | Perianth lobes dissimilar |
| Perianth lobes entire | Perianth lobes not entire |
| Stamens inserted at the base of the perianth | Stamens inserted on the perianth tube, or forming a staminal tube |
| Stamens 9 | Stamens 6 or 3 |

The subsection Chorizanthella (section Suffrutices) is considered very close to the South American perennials, and does, indeed, contain the South American annuals. *Chorizanthe brevicornu* and *C. spathulata,* North American members of subsection Chorizanthella, are separable from the austral perennials only in the annual habit and reduced number of stamens—the latter character not characterizing their subsection, however.

The ancestor of section Herbaceae is probably to be considered as an intermediate extinct group between the Perennes and Herbaceae, rather than in the Chorizanthella series. Figure 3 illustrates the probable relationship of the several subsections.

The subsection Pungentes is considered relatively primitive in the section because of the morphology of the flower. The lobes of the flower are entire and subequal, and the stamens are inserted at the base of the perianth. The large, foliaceous bracts, the compound uniparous cymes, and the margined involucres are thought to indicate, on the other hand, advanced characters.

Of the Herbaceae which do not possess involucral margins the subsection Staticoideae is considered the most primitive. The involucral teeth are always six, as they are in the entire section Herbaceae except part of subsection Flavae. The perianth lobes are prevailingly entire but of two different sizes. In the Uniaristatae the inner perianth lobes are fimbriate or at least erose, and the anterior involucral tooth is unusually long. The relationship of the members of this subsection is depicted in fig. 4.

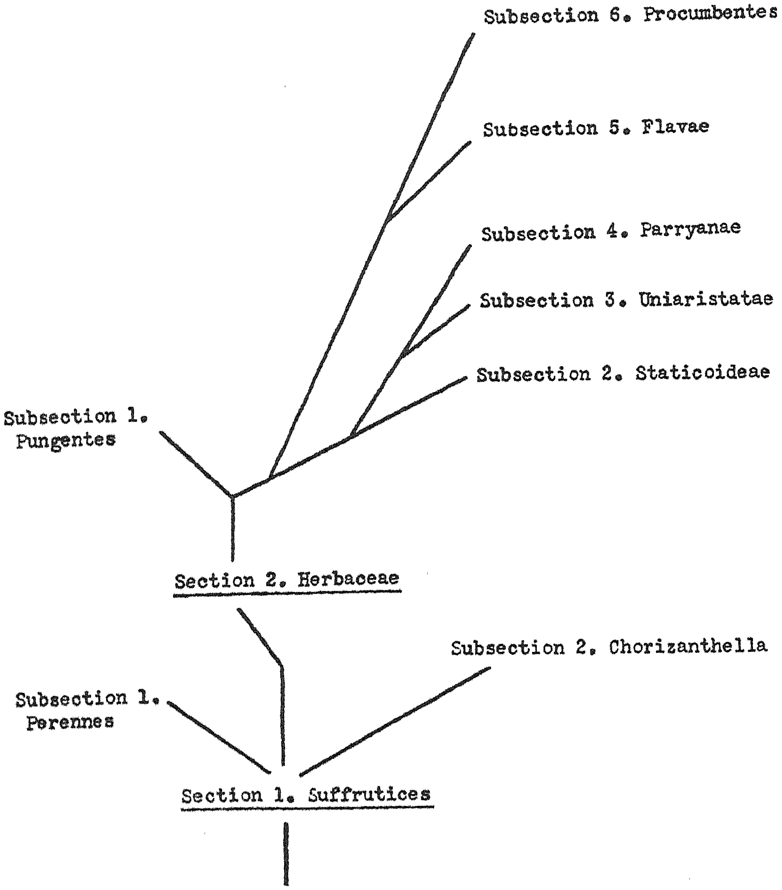

Fig. 3. Diagram illustrating the probable phylogeny of the genus *Chorizanthe.*

Subsection Flavae is considered advanced because of the obsolete inner involucral teeth of two of the three species, and because of the reduced condition of the uniparous cymes. Certain less important characters of this group call to mind the last subsection, the Procumbentes. This terminal group is considered the most advanced chiefly because of the presence of the staminal tube, which is constant in the group.

## THE SPECIFIC AND SUBSPECIFIC CONCEPTS

A few statements might be made concerning the specific and subspecific concepts used in this treatise. Two kinds of characteristics have been considered which are popular among present-day taxonomists, namely, the morphologic characters and the geographic distribution. As a working basis, at least two morphologic characters have been considered necessary to differentiate a species from its morphologically nearest relative. In all instances, species delimited in this way have been

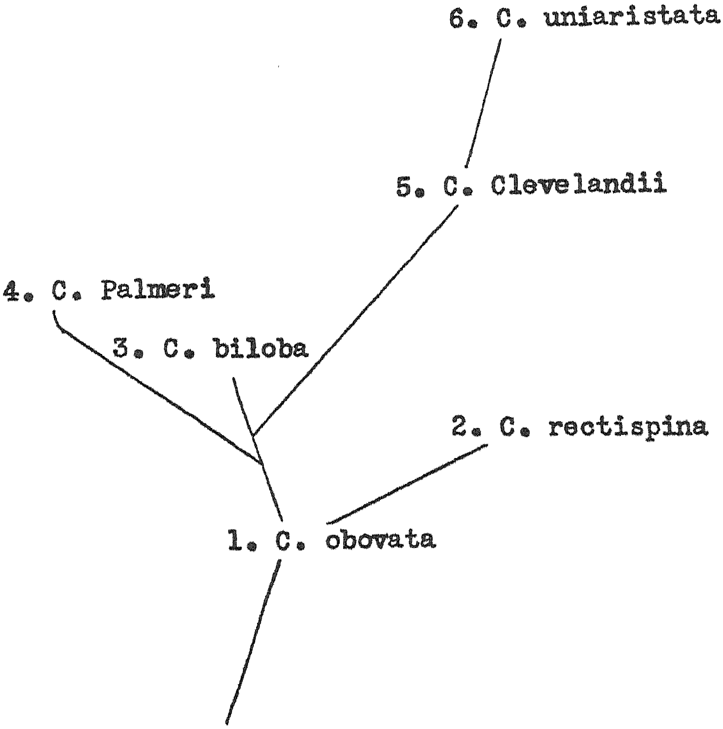

Fig. 4. Diagram depicting the relationship of the members of the subsection Uniaristatae.

found to possess a geographic range largely or quite different from that of the morphologically nearest relative.

Varieties have been established on a minimum of one constantly different character, providing the geographic range is not intermittent through the range of the parent species. More than one morphologic character has been considered necessary when the distribution is sporadic in the range of the species.

There is nothing new in this method of delimination, and the course followed, it is thought, is neither that of a "splitter" nor a "lumper," but rather, it is an intermediate course. It was chosen because it seemed to incorporate best those qualities which are so desirable to taxonomists—namely, accuracy and convenience.

## The Geographic Distribution

Both the North and South American members of the genus inhabit xerophytic habitats which, for the most part, lie between the Pacific Coast and the first ranges to the eastward. The South American species are found west of the Andes in the northern part of Chili. Subsection Chorizanthella, of the section Suffrutices, contains the South American annuals and the most widely distributed of the North American species. This subsection is represented in North America from Idaho and Washington to Arizona and Lower California.

All of the section Herbaceae is native to California and Lower California, and very rarely extends its distribution east of the coast ranges.

Each subsection is quite as much of a unit geographically as it is morphologically. The Pungentes have their center of distribution in Santa Cruz County, and at present no species is known from north of Mendocino County or south of Santa Barbara County, unless it be *C. angustifolia* Nutt., the type of which is said to have been collected at "Pueblo de los Angeles." In the light of subsequent collections, it is difficult to believe that the data are correct.

The Staticoideae have their center of distribution in Los Angeles County, and species are found north to Monterey County and south to Lower California. The two inland species of the Herbaceae belong to this group—*C. Xanti* inhabiting the San Joaquin Valley, and *C. laciniata* being found in the eastern half of San Diego County and in western Imperial County. One species of this group, *C. Wheeleri*, is almost endemic to the Santa Barbara Islands.

The Uniaristatae have as their center of distribution San Luis Obispo County, while subsections Parryanae and Procumbentes range from Los Angeles County into Lower California. The subsection Flavae is confined to Lower California.

## ACKNOWLEDGMENTS

The author is deeply indebted to numerous people whose aid and advice have been invaluable in the present study. For the privileges incident to studying at the Missouri Botanical Garden, the writer expresses his thanks to Dr. G. T. Moore, Director of that institution. Appreciation is due also to Miss Nell Horner, Librarian, for aid in assembling the bibliographic data. Most primarily are thanks due to Dr. J. M. Greenman, who has so generously given of his time in wisely and critically guiding the entire study.

Entire or partial collections of *Chorizanthe* have been borrowed from several herbaria, and certain herbaria have been visited, that the specimens of the genus might be examined. To those in charge of these collections, acknowledgments of gratitude are hereby made. The herbaria are the following:

CAS = Herbarium of the California Academy of Sciences.
CU = Herbarium of Columbia University.
D = Dudley Herbarium of Leland Stanford, Jr. University.
E = Herbarium of J. A. Ewan, Los Angeles.
F = Herbarium of the Field Museum of Natural History.
G = Gray Herbarium of Harvard University.
ISC = Herbarium of Iowa State College.
K = Herbarium of the Royal Botanic Gardens, Kew.
M = Herbarium of the Missouri Botanical Garden.
Par = Parry Herbarium of Iowa State College.
Pe = Herbarium of F. W. Peirson.

Ph = Herbarium of the Academy of Natural Sciences, Philadelphia.
Pom = Herbarium of Pomona College.
RMt = Rocky Mountain Herbarium, University of Wyoming.
UC = Herbarium of the University of California.
US = United States National Herbarium.

Preceding the name of each herbarium is its abbreviation as used in the taxonomic portion of this study.

## Taxonomy

**Chorizanthe** R. Br. ex Benth. Trans. Linn. Soc. Lond. **17**: 416. 1836; Spach, Veg. Phan. **10**: 521. 1841; Meisn. Pl. Vasc. Gen. 1: 317; 2: 229. 1836-1843; Benth. in DC. Prodr. **14**: 24. 1857; Torr. & Gray, Proc. Am. Acad. **8**: 192. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 269. 1877; Benth. & Hook. Gen. Pl. **3**: 93. 1880; Wats. Botany [of California] **2**: 33. 1880; F. Philippi, Cat. Pl. Vasc. Chil. 253. 1881; Parry, Proc. Davenp. Acad. Sci. **4**: 45. 1884; Behr, Fl. Vicinity San Francis. 277. 1888; Dammer in Engl. & Prantl, Nat. Pflanzenfam. $\mathbf{3^{1a}}$: 11. 1891; Greene, Fl. Francis. 153. 1891; Baillon, Hist. d. Pl. **11**: 399. 1892; Greene, Man. Bot. Reg. San Francis. Bay, 48. 1894; Heller, Cat. N. Am. Pl. 41. 1898; Jepson, Fl. West. Mid. Calif. 149. 1901, and ed. 2. 129. 1911; Howell, Fl. N. W. Am. 575. 1902; Abrams, Fl. Los Angeles & Vicinity, 112. 1904, and ed. 2. 103. 1917; Piper, Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 239. 1906; Jepson, Fl. Calif. 389. 1914; Rydberg, Fl. Rocky Mts. 229. 1917, and ed. 2. 229. 1922; Davidson & Moxley, Fl. So. Calif. 112. 1923; Jepson, Man. Fl. Pl. Calif. 295. 1923; Tidestrom, Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 144. 1925.

*Trigonocarpus* Bertero ex Steudel, Nom. ed. 2, **2**: 710, 1841, according to Hooker f. & Jackson, Ind. Kew. **2**: 1118. 1895, and de Dalle Torre & Harms, Gen. Siphon. 139. 1900-1907, not *Trigonocarpus* Vell. Fl. Flum. 153. 1825, and 145. 1881, nor of Wall.

*Lastarriaea* Remy in Gay, Fl. Chili 5: 289. 1849; Meisn. in DC. Prodr. **14**: 186. 1857; Torr. & Gray, Proc. Am. Acad. **8**: 199. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 477. 1871; Benth. & Hook. Gen. Pl. **3**: 94. 1880; Wats. Botany [of California] **2**: 39. 1880; Parry, Proc. Davenp. Acad. Sci. 5: 35. 1887; Behr, Fl. Vicinity San Francis. 278. 1888; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3$^{1a}$**: 10. 1891; Greene, Fl. Francis. 159. 1891; Heller, Cat. N. Am. Pl. 43. 1898; Jepson, Fl. West. Mid. Calif. 149. 1901, and ed. 2. 128. 1911; Abrams, Fl. Los Angeles & Vicinity, 112. 1904, and ed. 2. 103. 1917; Jepson, Fl. Calif. 389. 1914; Davidson & Moxley, Fl. So. Calif. 105. 1923; Jepson, Man. Fl. Pl. Calif. 294. 1923.

*Hamaria* Kunze, as to *Lastarriaea,* in Baillon, Hist. d. Pl. **11**: 397. 1892.

Fruticose or suffruticose perennials or herbaceous annuals, softly pubescent to tomentose. Stems erect to prostrate, dichotomously, or less frequently trichotomously, branched. Leaves basal, or cauline and alternate, entire, sometimes sheathing. Inflorescence of spreading, capitate, or uniparous cymes. Bracts foliaceous to subulate, opposite or, less frequently, whorled, entire. Involucres sessile at the forks of the branches, or rarely lacking, tube circular to triangular in cross-section, 3–6-ribbed, terminated by 6, or less frequently 3 (rarely 5), spines or teeth, these usually uncinate and spreading. Flowers solitary, commonly sessile or nearly so, included in the involucre or partially exserted, bractlets lacking; perianth frequently inconspicuously short-villous on the outer surface, 6-lobed (very rarely 5-lobed) or cleft, never parted, the lobes similar, or in two unequal sets of 3 each, entire or not. Stamens usually 9 (or 6 or 3), inserted at base of the perianth or, less frequently, on the tube, or united by the filaments into a short ciliate staminal tube, usually included; filaments glabrous; anthers orbicular to linear, 2-celled, longitudinally dehiscent. Achene 3-carpellate, 3-angled, glabrous; styles 3, stigmas capitate; ovule orthotropous, cotyledons linear and straight or nearly so.

Type species: *Chorizanthe virgata* Benth. Trans. Linn. Soc. Lond. 17: 416, *pl. 19, fig. 1.* 1836.

## Artificial Key to the Species and Varieties

A. Involucres present.
  B. Involucral teeth 6.
    C. Involucral teeth not scarious-margined.
      D. Anterior tooth usually shorter than the involucral tube, or if as long or longer, sharing this character with the other two teeth of the outer trio.
        E. All the perianth lobes entire or very nearly so.
          F. Perianth lobes similar or subsimilar.
            G. Involucral tube, as well as the perianth, 2–4 mm. long.
              H. Plants procumbent to ascending.
                I. Involucral teeth uncinate.
                  J. Plants gray-pubescent.
                    K. Outer involucral teeth of slender spines. Plants of Santa Barbara County and northward.
                      L. Perianth scarcely exceeding the involucre, lobes not apiculate. Plants of San Luis Obispo and Santa Barbara Counties.
                        M. Flowers 2.5–3 mm. long, stamens 7–9.......................*10a. C. angustifolia* var. *Eastwoodae*
                      MM. Flowers 2–2.5 mm. long, stamens 3........................................*10. C. angustifolia*
                      LL. Perianth definitely exceeding the involucre, lobes apiculate. Plants from vicinity of San Francisco Bay..............................*9. C. cuspidata*
                    KK. Outer involucral teeth stout. Plants of Lower California............................*40. C. chaetophora*
                  JJ. Plants greenish-yellow.
                    N. Perianth lobes broadly elliptic-ovate to elliptic oblong.
                      O. Outer involucral teeth stout, spinose portion very short............................*39. C. Jonesiana*
                      OO. Outer involucral teeth of slender spines.................................*38b. C. procumbens* var. *mexicana*
                    NN. Perianth lobes, at least the outer, oblong.
                      P. Flowers yellow.....................*38. C. procumbens*
                      PP. Flowers white.........*38a. C. procumbens* var. *albiflora*
                II. Involucral teeth straight......................*13. C. villosa*
              HH. Plants erect.
                Q. Leaves oblanceolate.......................*1. C. brevicornu*
                QQ. Leaves spathulate..........................*2. C. spathulata*
            GG. Involucral tube 5 mm. long, flower 6–7 mm. long.

R. Inner teeth evident............................*35. C. mutabilis*

RR. Inner teeth obsolete..............................*36. C. flava*

FF. Perianth lobes dissimilar.

S. Involucral teeth uncinate, or at least down-curved.

T. Plants without foliaceous bracts, or at least these not long persisting.

U. Perianth 4 mm. or less long.

V. Lobes oblong to narrowly elliptic.

W. Plants 3 dm. or less tall, leaves 7 cm. or less long.

X. At least 5 of the teeth consisting of scarcely more than a short uncinate spine...............................*18b. C. staticoides* var. *brevispina*

XX. Teeth longer, all tapering from a broadened base..................................*18. C. staticoides*

WW. Plants over 3 dm. tall, leaves 8–10 cm. long................................*18c. C. staticoides* var. *elata*

VV. Lobes, at least the outer, obovate.

Y. Involucral tube about 3 mm. long, teeth long and slender. Plants from vicinity of San Diego..........................................*22. C. discolor*

YY. Involucral tube more than 3 mm. long, teeth shorter than in the preceding species. Plants of Los Angeles County...........*18d. C. staticoides* var. *latiloba*

UU. Perianth 4.5–5.5 mm. long.

Z. Involucres in large, dense clusters, perianth 5–5.5 mm. long.

a. Plants not densely branched.........*19. C. chrysacantha*

aa. Plants densely branched...........................................*19a. C. chrysacantha* var. *compacta*

ZZ. Involucres very slender, disposed in small, loose clusters; perianth 4.5 mm. long.............*21. C. leptotheca*

TT. Plants with foliaceous bracts.

b. Perianths 4 mm. or less long. Plants coastal.

c. Bracts lanceolate.

d. Involucres closely aggregated in flat-topped cymes.........................*18a. C. staticoides* f. *bracteata*

dd. Involucres not closely aggregated in flat-topped cymes.

e. Clusters of involucres dense, spherical, 1–1.5 cm. broad. Plants chiefly of Santa Barbara Islands..................................*24. C. Wheeleri*

ee. Clusters of involucres less than 1 cm. broad. Plants of Los Angeles and southwestern San Bernardino Counties and southward...............*33. C. Parryi*

cc. Bracts, at least some of them, ovate to orbicular..............................................*23. C. Breweri* bb. Perianths 5–6 mm. long. Plants from east of the coast ranges.

f. Involucres not white-tomentose............... *20. C. Xanti*

ff. Involucres white-tomentose.... *20a. C. Xanti* var. *leucotheca*

SS. Involucral teeth straight.

g. Outer teeth 4 mm. or more long. Plants from the region of northern Lower California.................... *34. C. inequalis*

gg. Outer teeth shorter. Plants of Los Angeles and Orange Counties..................... *33a. C. Parryi* var. *fernandina*

EE. All the perianth lobes not entire.

h. Outer lobes of perianth entire or bilobed, the inner fimbriate.

i. The outer lobes entire.

j. Outer lobes obovate, inner oblong.

k. Plants erect............................... *27. C. obovata*

kk. Plants prostrate................ *27a. C. obovata* f. *prostrata*

jj. Outer lobes orbicular, inner retuse to emarginate.......... ........................................... *30. C. Palmeri*

ii. The outer lobes bilobed........................... *29. C. biloba*

hh. Outer and inner lobes erose or fimbriate.

l. All the lobes fimbriate.

m. Inner teeth evident.

n. Perianth 5.5–7 mm. long, terminal portion of lobes linear-oblong. Plants of west half of San Diego County and adjacent country to northward and southward........ ......................................... *25. C. fimbriata*

nn. Perianth 7–9 mm. long, terminal portion of lobe scarcely larger than the fimbriations. Plants of east half of San Diego County and adjacent country to north, east and south.................................. *26. C. laciniata*

mm. Inner teeth almost obsolete.................... *37. C. pulchella*

ll. All the lobes more or less erose.

o. Involucral teeth straight......................... *15. C. valida*

oo. Involucral teeth uncinate....................... *33. C. Parryi*

DD. Anterior involucral tooth as long as or longer than the tube, the other 5 teeth short.

p. The long tooth straight.

q. Flowers partly exserted, the outer lobes obovate, truncate, stamens 9......................................... *28. C. rectispina*

qq. Flowers included or nearly so, stamens 3.......... *32. C. uniaristata*

pp. The long tooth uncinate.......................... *31. C. Clevelandii*

CC. Involucral teeth scarious-margined.

r. Margins parted or divided at the sinuses.

s. Involucral teeth uncinate or recurved.

t. Foliaceous bracts present.

u. Involucres 4 mm. or less long, diffuse plants.

v. Lobes obovate to oblong, erose.

w. Margins of involucres light-colored. Plants of vicinity of Monterey Bay..........................*8. C. pungens*
ww. Margins of involucres purple. Plants chiefly of Santa Cruz County................*8a. C. pungens* var. *Hartwegi*
vv. Lobes not obovate to oblong, nor erose.
x. Perianth lobes oblong, entire, cuspidate.
y. Margins of involucre obsolete............*9. C. cuspidata*
yy. Margins of involucre evident and purplish...................................*9a. C. cuspidata* var. *marginata*
xx. Perianth lobes oblong, lanceolate, entire......*11. C. diffusa*
uu. Involucres more than 4 mm. long, erect plants.
z. Involucres hispid, margins white and evident....*17. C. stellulata*
zz. Involucres hirsute, margins not white............*14. C. robusta*
tt. Foliaceous bracts mostly lacking....................*11. C. diffusa*
ss. Involucral teeth straight.
1. Plants erect; involucres, as well as the flowers, 5–6 mm. long.........................................................*15. C. valida*
1′. Plants diffuse, flowers 4 mm. long..................*12. C. Howellii*
rr. Margins continuous through the sinuses.
2. Margins scarcely lobed, never cleft, purple...........*16. C. Douglasii*
2′. Margins cleft, white...............................*17. C. stellulata*
BB. Involucral teeth fewer than 6.
3. Involucral teeth 3.
4. Perianth 4 mm. or less long.
5. Involucres triangular in cross-section.
6. Bracts opposite. Plants from Pt. Loma, San Diego County.............................................*4. C. Orcuttiana*
6′. Bracts verticillate. Plants from Lower California.....................................................*6. C. interposita*
5′. Involucres cylindric.............................*5. C. corrugata*
4′. Perianth 6 mm. or more long.
7. Lobes entire.....................................*36. C. flava*
7′. Lobes fimbriate...............................*37. C. pulchella*
3′. Involucral teeth 5 (one larger than the others and frequently foliaceous)...................................*3. C. Watsoni*
AA. Involucres lacking.........................*7. C. Lastarriaca* var. *californica*

Section 1. Suffrutices Benth. Perennials, or if annuals, with the characters as given under subsection 2. Chorizanthella.

Subsection 1. Perennes, new subsection. South American perennials, represented by such species as *C. virgata* Benth., *C. glabrescens* Benth. (pl. 1, figs. 1 and 2), and *C. frankenioides* Remy. The subsection not here treated. The morphology of the involucres and flowers is similar to that of *C. brevicornu* of the next subsection.

Subsection 2. CHORIZANTHELLA Parry, emend. Erect or less frequently prostrate plants; stems several from the base, leaves basal, and the lower bracts foliaceous. Involucral teeth 6 and short, or 3, or rarely 5. Flowers frequently pedicellate. Perianth 2–4 mm. long, the lobes similar, entire or nearly so. Stamens frequently inserted well up on the perianth tube. Cotyledons longer than the radicle. Species 1–7 incl.

Range: Idaho and Washington, south to Arizona and Lower California; also in South America.

*C. commissuralis* Remy, a South American annual species closely related to *C. brevicornu,* and also the South American representatives of the former genus *Lastarriaea* belong to this subsection. The species with the largest distribution of the North American group also belong here.

1. **Chorizanthe brevicornu** Torr. Bot. Mex. Bound. **2**: 177. 1859; Torr. & Gray, Proc. Am. Acad. **8**: 196. 1870, excluding Watson's collection; Wats. U. S. Geol. Surv. Fortieth Parallel (Bot. King's Exp.) **5**: 312, 484. 1871, excluding plants with "leaves . . . spathulate-obovate," *Watson 1044,* and p. 484, "leaves . . . obovate-spathulate"; Wats. Proc. Am. Acad. **12**: 272. 1877, excluding plants with "leaves . . . broadly spathulate"; Wats. Botany [of California] **2**: 38, 481. 1880, excluding plants with "leaves broadly spathulate"; Hemsley, Biol. Cent.-Am. Bot. **3**: 33. 1882, including citation of Parry plant from Arizona; Parry, Proc. Davenp. Acad. Sci. **4**: 62. 1884; Jepson, Fl. Calif. 393, *fig. 68.* 1914; Rydb. Fl. Rocky Mts. 229. 1917, and ed. 2. 229. 1922; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 297, *fig. 319.* 1923; Tidestrom, Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 145. 1925, excluding synonymy.

Erect plants, 1–2 dm. tall, pubescent to pulverulent or glabrate, extremely fragile at the nodes when mature; branches ascending; leaves oblanceolate, frequently narrowly so, 3–6 cm. long; foliaceous bracts narrowly lanceolate to oblanceolate, apiculate, upper reduced, all opposite; involucres appearing singly in the axils of the branches of the cyme, narrowly subcylindric, curved, 4 mm. long, teeth 6, short, nearly equal, all uncinate; flowers short-pedicellate, usually included, 3–4 mm. long, glabrous, perianth tubes cylindric, slender, lobes similar, linear-oblong to lanceolate, nearly 1 mm. long; stamens 3, inserted at base of perianth opposite the inner segments, anthers small and suborbicular; achenes sometimes a little exserted from perianth, somewhat curved, cotyledons very slightly incumbently curved at tips.

Type: on the Gila River, March, *Parry*.

Distribution: southern and western Arizona, southwestern Utah, western Nevada, and Mono County, California, southward to the Lower California boundary.

Specimens examined:

ARIZONA: valley of Gila, October, 1871, *Mohr* (US); 1880, *Lemmon* (M); 1881, *Lemmon* (M, Par); mesa near Tucson, April 28, 1883, *Pringle* (M, Ph, US); Ft. Mojave, April, 1884, *Lemmon & wife* (US); Tucson, May 24, 1892, *Toumey 469b* (US); gravel, Beaverdam, alt. 1800 ft., April 5, 1894, *Jones 5034av* (Pom, US); Tucson Mts., March 13–April 23, 1903, *Griffiths 3486* (M, US); Oracle to Redington, March 13–April 23, 1903, *Griffiths 3722* (M, US); Coyote to Santa Rosa, March 13–April 23, 1903, *Griffiths 3981* (M, US); Coyote to Santa Rosa, March 13–April 23, 1903, *Griffiths 3991* (US); Franconia, alt. 900 ft., April 17, 1903, *Jones* (Pom); Congress Junction, alt. 3000 ft., May 2, 1903, *Jones* (Pom); Wickenburg, alt. 2100 ft., May 5, 1903, *Jones* (Pom); Phoenix, alt. 1000 ft., May 6, 1903, *Jones* (Pom); Santa Rita Forest Reserve, May 20–22, 1903, *Griffiths 4395* (M, US); north end Tucson Mts., April 22, 1908, *Rose 11870* (US); Santa Rita Range Reserve, May 11, 1912, *Wooton* (US); Phoenix, April 18, 1917, *Eastwood 6165* (CAS); Tucson, March 21, 1919, *Eastwood 8071* (CAS); Roosevelt Dam, May 17, 1919, *Eastwood 8667* (CAS); Topock, May 24, 1919, *Eastwood 8910* (CAS); Mormon Flats, March 7, 1926, *Peebles & Loomis 1033* (US); near Dome, March 6, 1927, *Harrison 3619* (US); Buck Mts., south of Yucca, April, 1928, *Braem* (D); Sierra Ancha, May 7, 1929, *Eastwood 16988* (CAS); Sacaton Mts., March 27, 1930, *Peebles 6532* (US); Oatman, April 21, 1931, *Eastwood 18188* (CAS).

UTAH: rocky slopes near St. George, 1874, *Parry* (M, Ph); 1876, *Johnson* (US); red sand, St. George, alt. 3000 ft., April 26, 1894, *Jones 5110al* (Pom, US); volcanic hillsides, Diamond Valley, May 19, 1902, *Goodding 881* (M, RMt, US).

NEVADA: Hawthorn, 1882, *Jones* (Par); near Hole in the Rock, alt. 1500 ft., April 13, 1894, *Jones 5036ap* (US); Mica Spring, alt. 4000 ft., April 13, 1894, *Jones 5045ao* (US); Amargosa Desert, alt. 3000 ft., April 26, 1907, *Jones* (Pom); Logan, May 5, 1909, *Kennedy 1851* (D, Ph); Indian Spring, May 5, 1909, *Kennedy 1851* (US); Rhyolite, alt. 3575 ft., May 17, 1909, *Heller 9680* (ISC).

CALIFORNIA: SANTA CRUZ COUNTY—Santa Cruz, June 29, 1881, *Jones* (Pom, US); MONO COUNTY—volcanic tableland, June 25, 1925, *Peirson 6037* (Pe); INYO COUNTY—Darwin, alt. 4600 ft., April 27, 1897, *Jones* (Pom); Panamint Cañon, alt. 2000 ft., May 3, 1897, *Jones* (D, Pom); rocky hills, Argus Mts., alt. 3000–4000 ft., April–September, 1897, *Purpus 5318* (M, US); Funeral Mts., Death Valley, alt. 2000 ft., April 9, 1907, *Jones* (Pom); Surprise Cañon, May 12, 1915, *Parish*

*10102* (D); wash of Wild Rose Cañon, Panamint Mts., alt. 2000 ft., March 20, 1924, *Ferris* 3948 (D); between Shoshone and Silver Lake, June 14, 1930, *Ferris 8007* (D, M); KERN COUNTY—on rocky hillside south of Mojave, May 5, 1920, *Johnston* (Pom); sandy flat, Muroc, May 20, 1929, *Hoffmann* (E); alluvial slopes, Red Rock Canyon, May 13, 1930, *Howell 4969* (CAS); Red Rock Canyon, May 13, 1930, *Peirson 8805* (Pe); SAN BERNARDINO COUNTY—Mojave River, May 23, 1876, *Palmer 469* (M); Mojave River, June 1, 1876, *Palmer 469* (M, US); Needles, May, 1884, *Jones* (US); Rabbit Spring, Mojave Desert, May–June, 1901, *Parish 4864* (D); Palm Springs, April 30, 1913, *Eastwood 3061* (CAS); Barstow, May 30, 1914, *Parish 9274* (D); Baxter, May 23, 1915, *Parish 9876* (D); dry, rocky hill, Barstow, April 13, 1919, *Munz 2601* (D, Pom); sandy wash, near Needles, alt. 700 ft., March 31, 1920, *Munz & Harwood 3618* (Pom); dry, sandy plain, near Warren's Well, alt. 3200 ft., May 6, 1922, *Munz & Johnston 5175* (Pom); between Barstow and Victorville, May 14, 1922, *Hart 78* (CAS); Salt Wells Canyon, March 20, 1924, *Ferris 3922a* (D); Barstow to Granite Wells, April 25, 1927, *Hart* (CAS); sandy soil, near Deadman's Point, alt. 3000 ft., July 9, 1927, *Howell 2678* (CAS); 39 miles from Needles, April 24, 1928, *Ferris 7222* (D); near Valley Wells, Trona, April 18, 1931, *Mathias 806* (M); Needles, April 23, 1931, *Eastwood 18246* (CAS); between Victorville and Lucerne Valley, April 30, 1932, *Eastwood 18803* (CAS); RIVERSIDE COUNTY—near Palm Springs, March, 1903, *Saunders* (Ph); Palm Springs, alt. 200 ft., May 10, 1903, *Jones* (Pom); Whitewater, alt. 1000 ft., May 11, 1903, *Jones* (Pom); near Pinto Mts., May, 1905, *Hall 6029* (D); Palm Springs, April 20, 1906, *Grant 6715* (D); Indio, April 27, 1906, *Jones* (Pom); south of Palm Springs, April 24, 1911, *Schellenger* (D, US); sandy soil, near Palm Springs, April 4–6, 1917, *Johnston* (Pom); sandy soil, near Palm Springs, April 4–6, 1917, *Johnston 1105* (D, Ph); Palm Springs, alt. 525 ft., April, 1920, *Jaeger 214* (US); sandy desert, near Palm Springs, alt. 500 ft., April 4, 1920, *Munz & Harwood 3517* (Pom); in desert sand, Mecca, 197 ft. below sea-level, March 16, 1921, *Spencer* (Pom); in sandy wash, Corn Springs, March 25, 1921, *Jaeger* (Pom); vicinity of Corn Springs, Chuckwalla Mts., alt. 1500 ft., April 9–12, 1922, *Munz & Keck 4859* (Pom); Palm Springs, March 26, 1926, *Abrams 11016* (D); Palm Springs to Palm Canyon, March 26, 1926, *Abrams 11060* (D); Palm Springs, April 20, 1926, *Beller* (M); Indio, June 1926, *Clark* (CAS); sandy soil, near Palm Springs, March 25, 1928, *Howell 3555* (CAS); stony east slope, Thousand Palms Canyon, March 13, 1932, *Fosberg 8066* (B); SAN DIEGO COUNTY—Mountain Springs, June, 1880, *Vasey 541* (US); near Agua Caliente, April, 1882, *Parish Bros. 828* (D); Colorado Desert, April, 1889, *Orcutt* (M, US); Mountain Spring, alt. 2500 ft., May 12, 1894, *Schoenfeldt 3076* (US); Mountain Spring, May 13, 1894, *Mearns 3145* (US); Signal Mt., April 2, 1903, *Abrams 3169* (D, M, Ph, Pom); San Felipe Creek, April 14, 1913, *Eastwood 2708* (CAS, US); in desert sand, Mountain Springs, alt. 2260 ft., May 3, 1918, *Spencer 802* (Pom); San Felipe Wash, near Banner, alt. 3000 ft., May 17, 1925, *Keck & McCully 88* (Pom); near Palm Wash, March 24, 1928, *Howell 3518* (CAS); IMPERIAL COUNTY—28 miles south of Coachella, April 12, 1922, *Peirson 4213* (Pe); in wash, near Picacho, April 20, 1928, *Ferris 7138* (D).

The slight arcuate curve mentioned in the description is manifest in many of the involucres. This character, together with the lax inflorescence and extreme brittleness of the nodes, makes this and the next species readily recognizable from the rest of the genus.

*C. brevicornu* has next to the largest range of any of the Chorizanthes here considered. The species is prevailingly greenish, even in age.

2. **Chorizanthe spathulata** Small ex. Rydb. Bull. Torr. Bot. Club **39**: 309. 1912; Rydb. Fl. Rocky Mts. 229. 1917, and ed. 2. 229. 1922; Tidestrom, Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 145. 1925, in synonymy.

*Chorizanthe brevicornu* Torr. & Gray, Proc. Am. Acad. **8**: 196. 1870, as to Watson's collection; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 312, 484. 1871, as to "leaves . . . spathulate-obovate," and *Watson 1044*, and p. 484, as to plants with "leaves . . . obovate-spathulate"; Wats. Proc. Am. Acad. **12**: 272. 1877, as to plants with "leaves . . . broadly spathulate"; Wats. Botany [of California] **2**: 38. 1880, as to plants with "leaves broadly spathulate."

Erect plants, 1–1.5 dm. tall, pubescent, reddish at maturity; branches ascending; leaves broadly spathulate, tapered to a winged petiole, 2–5 cm. long; bracts opposite, lower subfoliaceous and small, upper acerose; involucres solitary in the axils of the cymes, subcylindric, curved, 4–5 mm. long; flowers as in *C. brevicornu*.

Type: Big Butte Station, Idaho, June 23, 1893, *Palmer 230* (CU).

Distribution: Idaho, western Nevada, and part of adjacent California.

Specimens examined:

IDAHO: Shoshone, June 10, 1893, *Palmer 129* (US); Big Butte Station, June 23, 1893, *Palmer 230* (CU TYPE, M photograph, US); Murphy, Owyhee County, alt. 4000 ft., July 4, 1911, *Macbride 1033* (D, M, Pom, RMt, US); on black lava overflows, Shoshone, Lincoln County, July 18, 1911, *Nelson & Macbride 1171* (D, M, RMt); crevices in lava rocks, Picabo, Blaine County, alt. 4900 ft., July 3, 1916, *Macbride & Payson 3024* (CAS, D, Pom, RMt, US); Bruneau, June 23, 1930, *Jones 25782* (Pom).

NEVADA: Big Bend of the Truckee, alt. 4000 ft., May, 1868, *Watson 1044* (CU, US); Hawthorn, June 23, 1882, *Jones* (D, Pom); probably Tonopah, 1907, *Shockley* (D).

CALIFORNIA: MONO COUNTY—Green Creek, August 16, 1906, *Eastwood* (CAS); in sagebrush . . . Walker Creek, June 27, 1923, *Ferris 3728* (D); Mono Lake, August, 1923, *Michaels* (CAS); dry slopes about Whiskey Creek, Owens River, alt. 6700 ft., July 29, 1933, *Peirson 10739* (M, Pe); INYO COUNTY—Bishop Creek, alt. 5000 ft., June 1, 1906, *Hall & Chandler 7262* (Pom); Andrews Camp, Bishop Creek, July, 1911, *Davidson 2737* (D); sandy soil, Surprise Cañon, Panamint Mts., alt. 5000 ft., June 16, 1928, *Howell 3982* (CAS); Westegard Pass, alt. 5000 ft., July 10, 1930, *Hoffmann* (CAS, E); gravelly flat, Wild Rose Canyon, Panamint Mts., June 20, 1931, *Hoffmann 438* (CAS).

The spathulate leaves of this species separate it very well from its nearest relative, *C. brevicornu.* These leaves, however, in which such a good diagnostic character is to be found, are frequently lacking in the older specimens. Nevertheless, the species can still be recognized by the red color of the stems and involucres of the older plants, the broader involucres, as compared with *C. brevicornu,* and the geographic distribution.

3. **Chorizanthe Watsoni** Torr. & Gray, Proc. Am. Acad. **8**: 199. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 313, *pl. 34, figs. 4–6,* and 485. 1871; Wats. Proc. Am. Acad. **12**: 273. 1877; Wats. Botany [of California] **2**: 39, 481. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 54. 1884; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{1a}$: 11. 1891; Howell, Fl. N. W. Am. 576. 1902; Piper, Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 239. 1906; Jepson, Fl. Calif. 397. 1914; Rydb. Fl. Rocky Mts. 229. 1917, and ed. 2. 229. 1922; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 299. 1923; Tidestrom, Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 145. 1925.

Erect to ascending plants, about 1 dm. tall; stems considerably branched, canescent, green or reddish; leaves petiolate, oblanceolate, 2–3 cm. long, tomentose beneath, lanate above; bracts opposite, lower frequently similar to the leaves or narrower, upper acerose; involucres disposed singly or in small groups in the axils of the lax cyme, involucral tube cylindric, inconspicuously 5-ribbed, 3–4 mm. long, canescently ascending pubescent, 5-toothed, the teeth short and recurved to uncinate, except the anterior one—this foliaceous, lanceolate, from but little longer than the short teeth to 15 mm. long, terminated by a recurved awn; flowers included or very slightly exserted, pedicellate, 3–4 mm. long, yellow, perianth tubes cylindric, scantily pubescent, segments oblong, acute, 0.5–1 mm. long, equal; stamens 9, inserted on the perianth tube just below the lobes, filaments 0.5 mm. long, anthers oval; styles short.

Type: on borders of the desert, Reese River, Nevada, *Humboldt.*

Distribution: western Arizona, southwestern Utah, Nevada, southwestern Idaho, Washington, Oregon, and California.

Specimens examined:

Arizona: Chloride, alt. 4500 ft., April 14, 1903, *Jones* (Pom).

Idaho: Shoshone, June 10, 1893, *Palmer 126* (US); Shoshone, June 10, 1893, *Palmer 128* (CAS, M, Ph, RMt, US); north of Big Camas Prairie, alt. 5000 ft., July 14, 1895, *Henderson 3129* (US); Weiser, alt. 2200 ft., July 7, 1899, *Jones* (Pom); dry sandy slopes, Big Willow, alt. 3000 ft., May 31, 1910, *Macbride 159* (M, RMt, US); Glenn's Ferry, alt. 3000 ft., June 17, 1911, *Jones* (Pom); dry stony slopes, Three Creek, Owyhee County, July 2, 1912, *Nelson & Macbride 1875* (RMt, US); stony hillsides, near Dixie, Elmore County, alt. 4000 ft., June 24, 1916, *Macbride & Payson 2848* (RMt, US).

Utah: dry hillside, Diamond Valley, Washington County, alt. 4000 ft., June 2, 1929, *Cottam, Stanton & Harrison 4033* (Pom).

Nevada: Unionville Valley, alt. 4800 ft., June, 1868, *Watson 1046* (US); Humboldt Lake, alt. 4500 ft., May, 1868, *Watson 1046* (US); Pyramid Lake, September, 1874, *Lemmon* (US); Shoshone, June 6, 1881, *Jones* (Pom); Elko, June 14, 1882, *Jones* (Pom); Empire City, June 19, 1882, *Jones 2995* (CAS, D, M, Ph, Pom, RMt, US); Dayton, June 21, 1882, *Jones* (Pom.); Hawthorn, June 23, 1882, *Jones* (Pom); 1883, *Curran* (M); Alum Creek, Reno, June 30, 1893, *Hillman* (M); Reno, June 22, 1895, *Hillman* (D); Peavine foothills, Reno, June 25, 1895, *Hillman* (Pom); foothills, Reno, alt. 5500 ft., June 14, 1897, *Jones* (M, Pom, US); dry hills, Reno, alt. 5000 ft., June 19, 1900, *Stokes* (D, US); Eagle Valley, Ormsby County, alt. 1446 m., June 15, 1902, *Baker 1092* (M, Pom, US); Palisade, alt. 5000 ft., June 17, 1903, *Stokes* (US); Truckee Pass, Washoe County, alt. 4500 ft., June 14, 1906, *Kennedy 1308* (M, US); Rhyolite, alt. 3600 ft., June 1, 1907, *Shockley 56* (D); Riverside Park, Reno, alt. 4500 ft., May 26, 1909, *Heller 9705* (D, Ph); near Austin, July 26, 1913, *Kennedy 4536* (D); dry hills, near Austin, alt. 1950 m., July 27, 1913, *Hitchcock 764* (US).

Washington: dry hillsides, Wilson Creek, June, 1893, *Sandberg* (M); Wilson Creek, alt. 2000–3000 ft., June, 1893, *Sandberg & Leiberg* (ISC, Pom); near Wilson Creek, Douglas County, alt. 470 m., June 21, 1893, *Sandberg & Leiberg 258* (US); Pasco, May 25, 1899, *Piper 2960* (US).

Oregon: Union County, 1879, *Cusick 771* (US); dry hills, near Willow Creek, Baker County, June 17, *Cusick 1974* (M, US); base of Stein's Mts., May 30, 1885, *Howell* (CAS, Ph, US); Malheur Valley, near Harper Ranch, alt. 900 m., June 8, 1896, *Leiberg 2225* (CAS); dry ground, near Redmond, June 19, 1925, *Peck 13817* (D); dry sandy ground, near Redmond, June 19, 1925, *Peck 13847* (Ph); dry sandy ground, near Riley, June 22, 1925, *Peck 13847a* (D); dry ground, near Riley, June 22, 1925, *Peck 13852* (D, Ph); dry ground, near Folly Farm, Harney County, June 26, 1925, *Peck 13893* (D); dry gravelly slopes, near Brogan, May 25, 1927, *Henderson 8987* (CAS); dry slopes of Pueblo Mts., July 2, 1927, *Henderson 8989*

(CAS); dry ground, Jordan Valley, Malheur County, July 9, 1927, *Henderson 8988* (CAS).

CALIFORNIA: LASSEN COUNTY—Chat, alt. 5000 ft., June 18, 1897, *Jones* (Pom); INYO COUNTY—Bishop Creek, alt. 4750 ft., May 31, 1906, *Hall & Chandler 7247* (Pom); Lone Pine, May 13, 1927, *Jones* (Pom); Westgard Pass, White Mts., alt. 7300 ft., June 27, 1930, *Duran 517* (CAS, D, M); KERN COUNTY—Mojave, May, 1882, *Pringle* (M, Par, US); Mojave, May 25, 1882, *Pringle* (Ph); Mojave Desert, alt. 950 m., June 26, 1891, *Coville & Funston 1135* (US); Mojave, alt. 3000 ft., May 20, 1903, *Jones* (Pom); Mojave, May 13, 1913, *Eastwood 3235* (CAS, US); rocky hillside, near Mojave, May 5, 1920, *Johnston* (Pom); rocky hills between Rosamund and Mojave, April 30, 1927, *Abrams 11754* (D); El Paso Range, May 1, 1927, *Abrams 11932a* (D); alluvial slopes, Red Rock Canyon, May 13, 1930, *Howell 4976* (CAS); SAN BERNARDINO COUNTY—Mojave River, June 1, 1876, *Palmer 470* (M, Ph, US); Cajon Pass, alt. 3800 ft., May 16, 1903, *Jones* (Pom); on shady bench, Cajon Pass, alt. 3500 ft., May 15, 1920, *Johnston* (Pom); open, sandy plain, Deadman's Point, May 16, 1920, *Johnston* (Pom); sandy plain, near Victorville, May 16, 1920, *Johnston* (Pom); near Hesperia, May 17, 1920, *Johnston* (Pom); Hesperia, alt. 3000 ft., May 27, 1922, *Jaeger* (D); Foxesee Creek, alt. 6000 ft., June 25, 1922, *Peirson 3131* (Pe); sandy soil, Deadman's Point, alt. 3000 ft., June 12, 1927, *Howell 2518* (CAS); between Deadman's Point and Rabbit Springs, May 24, 1931, *Mathias 874* (M, Ph); dry field, 7 miles south of Box "S" Ranch, Mohave Desert, alt. 3700 ft., June 9, 1932, *Munz & Hitchcock 12776* (M); LOS ANGELES COUNTY—near Acton, May 21, 1893, *Hasse* (D); Rock Creek, San Gabriel Mts., alt. 4750 ft., June 16, 1918, *Peirson 394* (E, Pe); sandy wash, Big Rock Creek, San Gabriel Mts., May 19, 1929, *Hoffmann* (E); SAN DIEGO COUNTY—Agua Caliente, April, 1882, *Parish Bros. 1201* (D, ISC, M, Par, US); COUNTY NOT KNOWN—1874, *Lemmon 204* (M, Ph).

This species is unique in the genus in possessing 5 involucral teeth. The foliaceous one is commonly quite as large as the involucre and sometimes much larger. All degrees of variation may occur on the same plant, however, and such plants may occur in any part of the range.

*C. Watsoni* has the largest area of distribution of any species in the group here treated, and this range is not greatly different from that of its widely distributed relative, *C. brevicornu*.

The faucial insertion of the stamens characterize the remainder of the subsection Chorizanthella.

4. **Chorizanthe Orcuttiana** Parry, Proc. Davenp. Acad. Sci. 4: 54. 1884; Jepson, Fl. Calif. 396. 1914; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 299. 1923.

Pl. 1, fig. 3.

Spreading plants, about 1 dm. broad; stems appressed or spreading pubescent with rather straight hairs; leaves petiolate, narrowly oblanceolate, 1–2 cm. long, pubescent; bracts opposite, foliaceous and oblanceolate, or the upper short and acerose; involucres mostly solitary in the axils of the cymes, chartaceous, involucral tube definitely triangular in cross-section, 2 mm. long, ascending long-pubescent, teeth 3, squarrose, as long as the tube, spines abruptly uncinate; flowers pedicellate, barely exserted, perianths cylindric, narrowed above, 2–2.5 mm. long, segments erect, linear-lanceolate, subentire, 0.5 mm. long, short-villous; stamens 9, attached in a ring at the base of the segments, anthers orbicular; achenes smooth, styles short and straight.

Type: "Exposed sandy soil on Point Loma, San Diego, March, 1884." *C. R. Orcutt* (Par.)

Distribution: known only from Point Loma, San Diego County, California.

Specimens examined:

CALIFORNIA: SAN DIEGO COUNTY—Point Loma, March 13, 1884, *Orcutt & Cleveland* (D); Point Loma, March, 1884, *Orcutt* (Par TYPE); San Diego, March, 1884, *Cleveland* (CAS, D); Point Loma, April 2, 1884, *Orcutt* (Par); Point Loma, April, 1884, *Orcutt* (CAS, M, Par, US); Point Loma, April 25, 1897, *Brandegee* (Pom); Point Loma, April 28, 1905, *K. Brandegee* (D, US); Point Loma, April 28, 1905, *T. S. Brandegee* (Pom, US); Point Loma, April 10, 1906, *K. Brandegee 218* (CAS, D, M, Pom, RMt, US); Point Loma, March 28, 1914, *Parish 9111* (D).

This is a remarkable species, exceedingly limited in its distribution, and with no very close relatives, its nearest ally probably being *C. corrugata*. Superficially, *C. Orcuttiana* resembles *C. procumbens*, or to an extent, the former *C. polygonoides*.

A specimen in the herbarium of the Missouri Botanical Garden is accompanied by a label which reads, "Parry, Tehachipi." It is thought that this piece of data has been confused with that of another species.

5. **Chorizanthe corrugata** (Torr.) Torr. & Gray, Proc. Am. Acad. **8**: 198. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 485. 1871; Wats. Proc. Am. Acad. **12**: 273. 1877; Wats. Botany [of California] **2**: 39. 1880;

Parry, Proc. Davenp. Acad. Sci. 4: 53. 1884; Dammer in Engl. & Prantl, Nat. Pflanzenfam. $3^{1a}$: 11. 1891; Jepson, Fl. Calif. 397, *fig. 69.* 1914; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 299, *fig. 320.* 1923; Tidestrom, Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] 25: 145. 1925.

Pl. 1, figs. 4-5.

*Acanthogonum corrugatum* Torr. Pacif. R. R. Rept. 5: 364. 1856.

Erect plants, 0.5–1.5 dm. tall; stems silky spreading pubescent; leaves petiolate, mostly orbicular, 0.75–2 cm. in diameter, floccose-tomentose beneath, villous above; bracts opposite, lower spathulate, reduced and acerose above; lower involucres loosely disposed in the axils of the cymes, upper densely congested, involucral tube cylindric, transversely and obviously corrugated, shortly attenuated at base, 2–2.5 mm. long, glabrate, teeth 3, squarrose, as long as the tube or longer, occasionally foliose, the short spines down-curved, not uncinate; flowers included, pedicellate, subcylindric, 2–2.5 mm. long, segments oblong, obtuse, about 0.75 mm. long, subequal, pubescent; stamens 6, inserted at base of segments, anthers orbicular; achenes slightly exserted, papillose at top, styles short, straight.

Type: near Fort Yuma, Arizona, December, 1853, *General Thomas.*

Distribution: southern New Mexico, southern and western Arizona, and the inland parts of the southern half of California.

Specimens examined:

New Mexico: Rincon, April 30, 1884, *Jones* (Pom).

Arizona: Colorado River Valley, March, 1876, *Palmer 642* (M, Par, US); near Fort Mojave, April, 1884, *Lemmon & wife* (US); Franconia, alt. 900 ft., April 17, 1903, *Jones* (Pom); near Yuma, April 27, 1905, *Goldman 1089* (US); Yuma, April 25, 1906, *Jones* (Pom); Yuma, 1911, *Beard* (M); Sentinel, March 22, 1924, *Orcutt 91* (US); near Dome, March 6, 1927, *Harrison 3615* (US); near Mohawk, March 8, 1928, *Peebles & Harrison 5014* (US).

California: santa cruz county—Santa Cruz, June 29, 1881, *Jones* (Pom); inyo county—Salt Spring, Death Valley, May 24, 1915, *Parish 10016* (D); san bernardino county—Needles, May, 1884, *Jones* (US); Kelso, alt. 3000 ft., May 2, 1906, *Jones* (Pom); Baxter, May 23, 1915, *Parish 9887* (D); near Cottonwood Springs, alt. 500 ft., April, 1920, *Jaeger 213* (US); 28 miles north of Baker, April 1, 1928, *Howell 3501* (CAS); on volcanic rock, 28 miles north of Baker, April 1, 1928, *Peirson 7762* (Pe); near Riggs, April 3, 1928, *Munz & Hitchcock 10952* (Pom); near Parker, April 22, 1928, *Ferris 7305* (D); RIVERSIDE COUNTY—Colorado Desert, March, 1881, *Parry 272* (M, Par, US); Colorado Desert, April, 1905, *Brandegee* (US); Indio, April 20, 1913, *Piemeisel 3520* (US); near Blythe Junction, alt. 1200 ft., April 2, 1920, *Munz & Harwood* (Pom); Thousand Palm Canyon, alt. 500 ft., February 22, 1926, *Peirson 6509* (Pe); near Dos Palmos, March 13, 1926, *Hill* (Pom); Salt Creek Wash, March 20, 1927, *Reed 5477* (Pom); Thousand Palms, March 27, 1927, *Epling* (M); Painted Canyon, April 12, 1927, *Peirson 7175* (Pe, Pom); Dos Palmos, April 27, 1930, *Gilman* (Pom); SAN DIEGO COUNTY—Colorado Desert, April, 1889, *Orcutt* (M, US); Signal Mt., April 2, 1903. *Abrams 3222* (D); Agua Caliente, February 26, 1914, *Carlson* (CAS); Yaqui Wells, January 21, 1926, *Jones* (Pom); near Palm Wash, March 24, 1928, *Howell 3497* (CAS); IMPERIAL COUNTY—Mesquite, March, 1881, *W. F. Parish* (D); near Picacho, April 20, 1928, *Ferris 7140* (D); Midway Well, March 22, 1932, *Peirson 9795* (Pe); near Potholes, April 13, 1932, *Johansen & Ewan 7139* (E).

An outstanding species, easily recognized by the corrugations on the cylindric tubes of the involucres.

**6. Chorizanthe interposita** Goodman, n. sp.[26]

Ascending plants; stems 1–2 dm. long, short-villous with ascending or spreading hairs, reddish at maturity; leaves linear and very narrow; bracts verticillate, foliaceous and linear or reduced above, 4–8 mm. long; involucres solitary in the axils of the uniparous cymes, or in small clusters toward the ends of the branches, 5–6 mm. long, the involucral tube triangular in cross-section, 3 mm. long, pubescent, teeth 3, long and divergent, the short spines down-curved or uncinate; flowers nearly sessile, prismatic, 3–3.5 mm. long, submembranaceous, the 6 lobes lanceolate, recurved-apiculate, inner frequently a trifle narrower, 1–1.25 mm. long; stamens 7–9, inserted at the base of

[26] **Chorizanthe interposita** Goodman, sp. nov. Planta adscendens; caulibus 1–2 dm. longis, brevi-villosis, pilis adscendentibus vel diffusis; foliis linearibus et angustissimis; bracteis verticillatis, foliaceis et linearibus aut supra minutis, 4–8 mm. longis; involucris solitariis in axillis uniparitarum cymarum, vel ad terminos ramorum in glomerulis parvis, 5–6 mm. longis, involucri tubo prismatico, 3 mm. longo, pubescente, dentibus 3, longis et divergentibus, spinis brevibus, recurvatis vel uncinatis; floribus subsessilibus, prismaticis, 3–3.5 mm. longis, submembranaceis, 6 laciniis lanceolatis, recurvato-apiculatis, interioribus saepe angustioribus, 1–1.25 mm. longis; staminibus 7–9, ad basem laciniarum insertis, filamentis 0.5 mm. longis, singula glandula ad basem filamentarum, antheris orbicularibus; stylis brevibus.—San Quentin, Lower California, April 19, 1886, *C. R. Orcutt* (Mo. Bot. Gard. Herb. No. 128475 TYPE).

the lobes, filaments 0.5 mm. long, a gland at base of each on the perianth tube, anthers orbicular; styles short.

Type: San Quentin, Lower California, April 19, 1886, *C. R. Orcutt* (Mo. Bot. Gard. Herb. No. 128475).

Distribution: Lower California.

Specimens examined:
LOWER CALIFORNIA: San Quentin, April 19, 1886, *Orcutt* (M TYPE).

This intermediate species is an exceedingly interesting one. Superficially resembling the next (*C. Lastarriaea* var. *californica*) very closely, it can be differentiated from it by the narrower bracts, and, more especially, by the presence of a true, 3-toothed involucre containing a non-involucre-like perianth.

7. **Chorizanthe Lastarriaea** Parry var. **californica** (H. Gross) Goodman, n. comb.

*Lastarriaea chilensis* Remy subsp. *californica* H. Gross in Engl. Bot. Jahrb. **49**: 345. 1913.

*Lastarriaea chilensis* Remy in Torr. & Gray, Proc. Am. Acad. **8**: 199. 1870, as to North American specimens; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 477. 1871, as to North American specimens; Wats. Botany [of California] **2**: 39. 1880, as to North American specimens; Parry, Proc. Davenp. Acad. Sci. **5**: 36. 1887, as to North American specimens; Behr, Fl. Vicinity San Francis. 278. 1888; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{1a}$: 10, *fig. 4E*. 1891, as to North American specimens; Greene, Fl. Francis. 159. 1891; Jepson, Fl. West. Mid. Calif. 149. 1901, and ed. 2. 128. 1911, both as to North American specimens; Abrams, Fl. Los Angeles & Vicinity, 112. 1904, and ed. 2. 103. 1917; Jepson, Fl. Calif. 389. 1914, as to North American specimens; Davidson & Moxley, Fl. So. Calif. 105. 1923; Jepson, Man. Fl. Pl. Calif. 295. 1923, as to North American specimens.

*Chorizanthe Lastarriaea* Parry, Proc. Davenp. Acad. Sci. **4**: 63. 1884, as to North American specimens; Parry, West. Am. Sci. **1**: 29. 1885.

Ascending to prostrate plants; stems about 1–1.5 dm. long, pubescent with spreading or ascending hairs; leaves narrowly linear, less than 1 mm. wide, 2–2.5 cm. long, ciliate; bracts in verticils of 4 or 5, usually connate at base only, lanceolate to linear, 4–7 or 9 mm. long; involucres lacking; flowers solitary in the axils of the uniparous cymes, perianth 4 mm. long, coriaceous, ciliate, tube prismatic, 2 mm. long, lobes 5, two shorter than the others, long-spinose, divergent, uncinate; stamens 3 or more, inserted near the base of the perianth lobes, anthers small and orbicular; styles short.

Type: mesas, San Bernardino Valley, California, April, 1882, *Parish 819*.

Distribution: Monterey County, California, southward into Lower California.

Specimens examined:

CALIFORNIA: MONTEREY COUNTY—sandy fields, Monterey, July 18, 1882, *Pringle* (M); SANTA BARBARA COUNTY—sea bluffs at East Point, Santa Rosa Island, April 9, 1930, *Munz & Hoffmann 11734* (Pom); SAN BERNARDINO COUNTY—1876, *Parry & Lemmon 371* (M); mesas, San Bernardino Valley, April, 1884, *Parish Bros. 819* (M); Colton, April 29, 1889, *Parish* (M); dry mesas, near San Bernardino, alt. about 300 m., May 17, 1917, *Parish 11217* (Pom); sandy washes, Highland, alt. 1000 ft., May 9, 1919, *Spencer 1110* (Pom); RIVERSIDE COUNTY—Whitewater, alt. 1000 ft., May 11, 1903, *Jones* (M, Pom, US); near Murietta, alt. 1500 ft., May 19, 1922, *Munz & Johnston 5364* (Pom); LOS ANGELES COUNTY—Pasadena, May 3, 1882, *Jones* (Pom); dry ridges, Santa Monica, May, 1890, *Hasse* (M); dry hills, April, 1891, *Hasse* (M); Ballena Harbor, April 1, 1901, *Abrams 1218* (M, Pom); Santa Catalina Island, May 7, 1902, *Trask* (M); sandy soil, between Claremont and Upland, June 2, 1921, *Robinson 94* (Pom); dry soil, San Gabriel Wash, alt. 350 ft., May 26, 1932, *Wheeler 745* (M); SAN DIEGO COUNTY—Fallbrook, March 28, 1882, *Jones* (Pom); San Diego, April 3, 1882, *Jones* (Pom); Point Loma, May 7, 1902, *Brandegee 1623* (M, Pom); San Diego, March–June, 1906, *K. Brandegee* (M); mesa near San Diego, alt. 4000 ft., *Peirson 3360* (Pe); COUNTY NOT KNOWN—1868-1869, *Kellogg & Harford 865* (M, US); 1882, *Parry* (M).

LOWER CALIFORNIA: Todos Santos Bay, April 7, 1886, Orcutt (M): San Quentin Bay, February, 1889, *Palmer 722* (US).

The acceptance of Gross' subspecific name is made even though the writer possesses a lack of full knowledge of the South American representatives of the former Lastarriaeas. Certainly the North American species are distinguishable from the plant delineated in the plate accompanying the original description of *Lastarriaea chilensis*,[27] but whether or not one of

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[27] Remy in Gay, Fl. Chili 5: 290. 1849; Gay, Hist. Chili, Atlas Bot. 1: *pl. 58, fig. 1.* 1854.

Philippi's species of *Lastarriaea* would not include var. *californica* is not known.

The absence of certain of the bracts which would normally form the involucre, the reduction of the perianth lobes to 5, and the faucial insertion of the stamens all indicate, it is thought, *C. Lastarriaea* to be the most highly evolved of this series of Chorizanthes.

Section 2. HERBACEAE Benth., in large part. North American annuals, differing chiefly from the annual Suffrutices in the prevailingly larger outer teeth of the involucres as compared with the tube, and the differentiation of the teeth into a long outer trio and a shorter alternating trio. Cotyledons longer than the radicle.

Subsection 1. PUNGENTES, new subsection. Erect or decumbent plants with spreading pubescence. Lower bracts foliaceous or rarely reduced, upper acerose and ciliate. Involucres 6-ribbed and 6-toothed, the teeth prevailingly margined, the alternating 3 shorter except in one species, the anterior tooth a little longer than any of the others. Perianth scantily pubescent on the outer surface, the lobes mostly equal or subequal. Stamens prevailingly 9, inserted at the base of the perianth. Species 8–17, incl.

Range: coastal or in the coast ranges of California from Monterey County to Sonoma County, with outlying species as far north as Mendocino County, and southward into Santa Barbara County; and one species inland in northern California.

8. **Chorizanthe pungens** Benth. Trans. Linn. Soc. Lond. **17**: 419, *pl. 19, fig. 2.* 1836; Torr. Pacif. R. R. Rept. **4**: 132. 1856; Benth. in DC. Prodr. **14**: 26. 1857; Torr. and Gray, Proc. Am. Acad. **8**: 194. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 270. 1877; Wats. Botany [of California] **2**: 36, 481. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 60. 1884; Behr, Fl. Vicinity San Francis. 278. 1888; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{1a}$: 12. 1891; Greene, Fl. Francis. 155. 1891; Greene, Man. Bot. Reg. San Francis. Bay, 49. 1894; Jepson, Fl. West.

Mid. Calif. 151. 1901, and ed. 2. 130. 1911; Jepson, Fl. Calif. 392, *fig. 67c.* 1914; Jepson, Man. Fl. Pl. Calif. 296, *fig. 318.* 1923, excluding vars. Pl. 1, figs. 10–11.

*Chorizanthe Douglasii* Benth. var. *albens* Parry, Proc. Davenp. Acad. Sci. 5: 175. 1889; Greene, Fl. Francis. 154. 1891.

Diffuse plants; stems several from the base, 1–3 dm. long, grayish with widely spreading villous hairs; leaves basal, petiolate, oblanceolate, 3–5 cm. long, ascending villous; bracts opposite, the lower similar to the leaves, upper acerose; involucres in dense clusters in compound uniparous cymes, 3.5–4 mm. long, the involucral tube subcylindric, 2–3 mm. long, hispidulous on the ribs with widely spreading hairs, the teeth divergent, straight except for the prevailingly uncinate tip, the alternate 3 a little smaller, plainly margined with a light-colored membrane, this cleft or divided at the sinuses; flower partially exserted, narrowly obconic, 3–3.5 mm. long, perianth lobes subequal and erose, nearly half as long as the tube, the outer 3 obovate or oblong, rounded to truncate, sometimes mucronate, inner oblong, similar, often a little shorter; stamens 9, anthers small and oblong; achene 3 mm. long.

Type: "California, coll. of 1833," *Douglas* (K).

Distribution: northern Monterey County, California.

Specimens examined:

CALIFORNIA: MONTEREY COUNTY—1833, *Douglas* (K TYPE, M photograph); pastures near Monterey, 1848, *Hartweg 1936* (K); Monterey, 1850, *Parry* (US); sandy soil, Monterey, July 8, 1880, *Engelmann* (M); 1880, *M. E. Norton* (US); Monterey, 1881, *Lemmon* (Par); in sandy places, Monterey, July 19, 1882, *Pringle* (Ph); Salinas Valley, April 20, 1888, *Parry* (M, Par TYPE of *C. Douglasii* var. *albens*, US); Hotel del Monte grounds, May 1, 1888, *Hasse* (M); Seaside, April 13, 1894, *Dudley* (D); Pacific Grove, June–July, 1898, *Nott* (D); sandy beach, May 16, 1900, *Grant* (D); Del Monte, May 16, 1900, *Grant 2605* (Pom); Del Monte, April, 1902, *Elmer 3570* (CAS, D, M, US); near Seaside, May 19, 1903, *Heller 6749* (D, M, Ph, Pom, RMt, US); Moss Beach, June 10, 1906, *McGregor 42* (D); Pacific Grove, June 7, 1907, *Patterson & Wiltz* (D); Seaside, March 31, 1910, *Randall 221* (D); Seaside, May 29, 1912, *Eastwood 150* (US); near Monterey, June 27, 1923, *Peirson 3707* (Pe); Monterey Point, June 9, 1929, *Dearing* (E).

A specimen of Nuttall's which seems referable to *pungens* is labeled "St. Simeon" (San Luis Obispo County). Two specimens from near Castroville, Monterey County (*K. Brandegee,* June 16, 1908, and *Dearing,* June 9, 1929) are doubtfully referred to this species.

*C. pungens* has been considered one of the most variable species in the genus, and while it is still to be regarded as variable, it is not unusually so as here delimited. The size of the plant and the character of the perianth lobes are the most variable characters; the pubescence and the character of the involucral teeth being, perhaps, the next.

Parry's *C. Douglasii* Benth. var. *albens* is here considered a white-pubescent phase of *C. pungens.* The reason that Parry referred this variety to *Douglasii* is apparently because even after having seen type material of *Douglasii* the outstanding character of the continuous involucral membrane was overlooked. Most or all of the plants which Parry referred to *C. Douglasii,* the present writer would designate as the purple-margined variety of *pungens,* namely, var. *Hartwegi.*

The figure of the involucre of *C. pungens* which accompanies Bentham's original description shows the involucral teeth as straight. It happens that on the type specimen the teeth are straight on many of the involucres, on the others they are uncinate. Though the latter condition prevails, straight teeth are sometimes met with.

**8a. Chorizanthe pungens** Benth. var. **Hartwegi** (Benth.) Goodman, n. comb.

*Chorizanthe Douglasii* Benth. var. *Hartwegi* Benth. in DC. Prodr. **14**: 26. 1857; Torr. & Gray, Proc. Am. Acad. **8**: 194. 1870, in synonymy.

Less decumbent than the species, spreading villous-pubescent, sometimes hoary; stems, leaves, bracts, and inflorescence similar to the species; involucres commonly purplish, especially the marginal membrane, the latter parted or divided at the sinuses, otherwise as in the species; flower partly exserted, narrowly obconic, 3–3.5 mm. long, often yellowish, outer lobes obovate to oblong, erose, very often mucronate, inner oblong, similar; stamens 9, anthers small, oblong.

Type: dry mountain pastures near Santa Cruz, California, coll. of 1848, *Hartweg 1935* (K).

Distribution: Santa Cruz County, California, and occasionally adjacent counties to north and south.

Specimens examined:

CALIFORNIA: SAN FRANCISCO COUNTY—San Francisco, July 16, 1881, *Jones* (Pom); SANTA CRUZ COUNTY—dry mountain pastures near Santa Cruz, 1848, *Hartweg 1935* (K TYPE, M fragment and photograph); Santa Cruz, 1881, *Jones* (US); Santa Cruz, July 1, 1881, *Jones 2327* (Pom); Santa Cruz, June, 1882, *Parry* (M, Par); Santa Cruz Mts., July 13, 1882, *Pringle* (M, US) Santa Cruz Mts., July 15, 1882, *Pringle* (Ph); sandy fields, Santa Cruz Mts., July 26, 1882, *Pringle* (M, US); Santa Cruz Mts., 1883, *Parry* (US); Santa Cruz, 1888, *Parry* (M, Par, US); Ben Lomond, 1888, *Parry 13* (Par); Flat Rock, Big Basin, May 29, 1897, *Dudley* (D); near Eccles, Santa Cruz Mts., June 26, 1897, *Dudley* (D, M); Ben Lomond, May, 1903, *Elmer 4671* (CAS, D, M, US); Felton, July 11, 1903, *Mrs. B. H. Thompson* (M); Felton, July 11, 1903, *C. H. Thompson* (D); Santa Cruz, June 21, 1917, *Reed* (CAS); sandy hills near Mt. Hermon, May 18, 1926, *Bacigalupi 1491* (D); Santa Cruz Mts., June 16, 1929, *Rowntree* (Pom); sand hills, Ben Lomond, June 20, 1933, *Rose 33235* (CAS); MONTEREY COUNTY—sandy fields, July 16, 1882, *Pringle* (M, US); Pacific Grove, July 8, 1914, *Newell* (CAS, US).

This variety, ranging just to the north of the species, is usually readily distinguishable from *C. pungens* by the purplish involucral margin. The flowers generally have more evidently obovate, erose and mucronate outer lobes, and in this respect the variety does approach *C. Douglasii.*

9. **Chorizanthe cuspidata** Wats. Proc. Am. Acad. **17**: 379. 1882; Greene, Fl. Francis. 156. 1891; Greene, Man. Bot. Reg. San Francis. Bay, 49. 1894.

*Chorizanthe pungens* Benth. var. *cuspidata* (Wats.) Parry, Proc. Davenp. Acad. Sci. **4**: 60. 1884; Jepson, Fl. Calif. 392. 1914; Jepson, Man. Fl. Pl. Calif. 297. 1923.

Decumbent plants; stems 1–2.5 dm. long, spreading villous; leaves basal, petiolate, oblanceolate, 2–3.5 cm. long, clothed with short, ascending, villous hairs; bracts opposite, lower similar to the leaves, upper acerose; involucres 3.5–4 mm. long, in dense clusters on the compound, uniparous cymes, involucral tube triangular in cross-section, campanulate to urceolate, about 2 mm. long, pubescent to glabrate, the teeth spreading and uncinate, marginal membrane lacking or vestigial; flower partly exserted, subcylindric, 2–2.5 mm. long, outer segments oblong, half as long as the perianth tube, inner a trifle shorter and narrower, all entire and tipped with a short cusp; stamens 9, anthers oblong.

Type: San Francisco, California, July 16, 1881, *M. E. Jones 2386* (G).

Distribution: chiefly in vicinity of San Francisco, California, and in adjacent counties to the northward and southward.

Specimens examined:

CALIFORNIA: SONOMA COUNTY—sand hills at north end of Bodega Bay, June 8, 1930, *Howell 5271* (CAS); SAN FRANCISCO COUNTY—San Francisco, *Wilkes 1522* (US); near San Francisco, 1865, *Torrey 434* (US); sandy fields, San Francisco, May 1, 1865, *Bolander 112* (M); San Francisco, May 16, 1868, *Kellogg & Harford* (RMt, US); San Francisco, June 16, 1868, *Kellogg & Harford* (D, M, US); San Francisco, June 16, 1868, *Kellogg & Harford 6* (US); Lone Mountain, San Francisco, July 10, 1868, *Kellogg & Harford* (US); Merced Lake, August 22, 1868, *Kellogg & Harford* (US); San Francisco, July 16, 1878, *Moore* (CAS); near San Francisco, 1880, *Vasey 539* (US); San Francisco, July 16, 1881, *Jones* (Ph); Golden Gate Park, July 16, 1881, *Jones 186* (Pom); San Francisco, July 16, 1881, *Jones 2386* (D, M, Pom, US ISOTYPES); San Francisco, 1882, *Parry* (M); San Francisco, May 12, 1882, *Jones* (CAS, Pom); San Francisco, May 19, 1882, *Jones* (Pom); Golden Gate Park, June, 1882, *Parry* (M); San Francisco, June, 1886, *Curran* (D); Lake Merced, June, 1892, *Michener & Bioletti* (US); Lone Mountain, San Francisco, June 3, 1894, *Dudley* (D); between Presidio and park, San Francisco, May 21, 1896, *Cannan* (US); between Presidio and park, San Francisco, May 21, 1896, *Eastwood* (CAS); Lake Merced, June 8, 1902, *Heller 5666* (D, M, Ph, Pom, RMt, US); vicinity of Lake Merced, May, 1903, *Gardner 548* (US); sand hills near San Francisco, May 3, 1903, *Baker 2842* (M, Pom, RMt, US); near San Francisco, June, 1903, *Baker 5072* (D, Pom); San Francisco, 1905, *K. Brandegee* (M, Pom, RMt, US); sand dunes, near Lake Merced, April 24, 1926, *Howell 1956* (CAS); near Sutro Heights, San Francisco, June 21, 1930, *Howell 5316* (CAS); sandy ground near Relief Home, San Francisco, June 1, 1933, *Eastwood* (CAS); Lake Merced, San Francisco, July 9, 1933, *Howell 11430* (CAS); SAN MATEO COUNTY—Crystal Springs Lake, May, 1903, *Elmer 4793* (M, US); San Pedro, May, 1903, *Elmer 4793* (CAS, D, Pom); SANTA CRUZ COUNTY—Santa Cruz, June, 1881, *Jones* (US); COUNTY NOT KNOWN—1866, *Bolander* (US); *Bridges 286* (US).

*C. cuspidata* has been considered as but a variety of *C. pungens* by some taxonomists, but the present comparative study indicates it as a good species. It is true that the involucral membranes in *C. cuspidata* are not always completely lacking, and they are regularly present in the variety *marginata*, thus evidencing close relationship to *pungens*. However, important differentiating characters are to be found in a more fundamental organ, namely, the perianth. Here the smaller flower, and the narrow, entire to subentire, apiculate lobes amply separate the species from *C. pungens*. Further, the range of *C. cuspidata* is quite distinct from that of *C. pungens*.

**9a. Chorizanthe cuspidata** Wats. var. **marginata** Goodman, n. var.[28]

Ascending to decumbent plants; stems 2–4 dm. long, spreading villous; leaves basal, petiolate, oblanceolate to spathulate, 3.5–5 cm. long; lower bracts similar to the leaves, upper acerose; inflorescence as in the species; involucres ascending pubescent, the teeth margined with an evident membrane, this and the involucral tube often purplish; otherwise as in the species.

Type: San Pedro, San Mateo County, California, May, 1903, *Elmer 4828* (M).

Distribution: San Francisco and San Mateo Counties, California, and rarely southward.

Specimens examined:

CALIFORNIA: SAN FRANCISCO COUNTY—San Francisco, 1905, *K. Brandegee* (D); near Ocean View, June 8, 1906, *Heller 8383* (CAS, D, M, Ph, US); Laurel Hill Cemetery, June 6, 1912, *Eastwood 222* (CAS, US); Lake Merced, May 20, 1918, *Eastwood* (CAS); SAN MATEO COUNTY—Colma, May 11, 1901, *Abrams 1603* (D, Pom, RMt); near Colma, May 11, 1901, *Dudley* (D); San Pedro, May, 1903, *Elmer 4828* (CAS, D, M TYPE, Pom, US); MONTEREY COUNTY—Seaside, May 29, 1912, *Eastwood 150a* (CAS); COUNTY NOT KNOWN—1875, *Vasey* (US).

This variety is intermediate between *C. cuspidata* and *C. pungens* var. *Hartwegi*, and probably gave rise to the former. The floral morphology serves definitely to ally the new variety to *C. cuspidata*, and the geographic distribution agrees with such a contention.

The specimens of *C. cuspidata* var. *marginata* thus far seen average larger, more erect, and possess larger bracts than do those of typical *cuspidata*.

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[28] **Chorizanthe cuspidata** Wats. var. **marginata** Goodman, var. nov. Planta adscendens vel decumbens; caulibus 2–4 dm. longis, diffuse villosis; foliis basalibus, petiolatis, oblanceolatis vel spathulatis, 3.5–5 cm. longis; bracteis inferioribus foliis similibus, superioribus acerosis; inflorescentia speciei simile; involucris adscendente pubescentibus, margine dentium membrana purpurascente, tubo involucri saepe purpurascente. Cetera speciei similis.—San Pedro, San Mateo County, California, May, 1903, *Elmer 4828* (M TYPE).

**10. Chorizanthe angustifolia** Nutt. Jour. Acad. Phila. N. S. 1: 167. 1848; Benth. in DC. Prodr. **14**: 26. 1857, excluding specimens from near San Francisco; Torr. & Gray, Proc. Am. Acad. 8: 194. 1870, in synonymy.

Decumbent plants; stems several from the base, 1–4 dm. long, canescent with ascending hairs; leaves basal, petiolate in the larger plants, oblanceolate, 2–5 cm. long, gray with villous hairs; bracts similar, reduced above; inflorescence of numerous medium-sized clusters of involucres, rather closely arranged on compound uniparous cymes; involucres about 3.5 mm. long, the tube cylindro-triangular in cross-section, 2 mm. long, with spreading, villous hairs, teeth slender, spreading, straight except for the uncinate tips, the larger as long as the tube, marginal membranes lacking; flower scarcely exserted, cylindric, 2–2.5 mm. long, lobes similar, oblong, acute to truncate and erose at apex, 0.75 mm. long; stamens 3, anthers suborbicular, minute.

Type: "Pueblo los Angeles, Upper California," *Gambel* (Ph).

Distribution: probably only Santa Barbara County, California.

Specimens examined:

CALIFORNIA: near Santa Maria, Santa Barbara County, June 13–July 3, 1906, *Eastwood 351* (CAS); sandy soil near Buellton, Santa Barbara County, May 30, 1929, *Hoffmann* (E); "Pueblo los Angeles," *Gambel* (M photograph, Ph TYPE).

This species, the most southern of the subsection Pungentes, is doubtless a derivative of *C. pungens* (or an ancestor similar to *C. pungens*). *C. angustifolia* has undergone some of the same evolution, in the loss of the marginal membrane of the involucre, that *C. cuspidata,* whose range lies to the north of that of *C. pungens,* has manifested.

Grayish plants in aspect, they are readily recognized as "*pungens*" relatives, despite the lack of the characteristic involucral margins, by the foliaceous, opposite, oblanceolate bracts, and the inflorescence.

The name *C. angustifolia* has not appeared in any treatments of *Chorizanthe* since Torrey and Gray put the species in synonymy in 1870, and collections made during the past several years which were referable to this species or its variety have, of course, been troublesome.

In the light of subsequent collections, it seems unlikely that the type of *C. angustifolia* was collected as far south as Los Angeles.

**10a. Chorizanthe angustifolia** Nutt. var. **Eastwoodae** Goodman, n. var.[29]

Flowers 2.5–3 mm. long, stamens 8–9. Otherwise as the species.

Type: sandy soil, Morro Bay, San Luis Obispo County, California, May 16, 1928, *Eastwood 15108* (CAS).

Distribution: San Luis Obispo and Santa Barbara Counties, California.

Specimens examined:

CALIFORNIA: SAN LUIS OBISPO COUNTY—dry hills, near coast, 1884, *Summers* (US); Haynes ranch, July, 1912, *Ingalls* (CAS); sand hills near Pismo Beach, June 10, 1917, *Abrams 6516* (D); Morro, April 7, 1927, *Eastwood 14266* (CAS); Morro Bay, May 16, 1928, *Eastwood 15102* (CAS); Morro Bay, May 16, 1928, *Eastwood 15108* (CAS TYPE, D, M photograph); between Guadelupe and Callender, April 15, 1929, *Ferris 7613* (D); near San Luis Obispo, *Roadhouse 401* (US); SANTA BARBARA COUNTY—sand dunes, Surf, April 20, 1929, *Peirson 8310* (CAS, Pe); sandy field, Santa Maria, April 22, 1929, *Hoffmann* (E); near Buellton, May 31, 1931, *Hoffmann* (Pom).

Most of the "*angustifolia*" material is referable to this less reduced variety.

**11. Chorizanthe diffusa** Benth. Pl. Hartweg. 333. 1857; Benth. in DC. Prodr. **14**: 26. 1857; Torr. & Gray, Proc. Am. Acad. **8**: 193. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 270. 1877; Wats. Botany [of California] **2**: 36, 481. 1880; Greene, Fl. Francis. 156. 1891.

*Chorizanthe pungens* Benth. var. *diffusa* (Benth.) Parry, Proc. Davenp. Acad. Sci. **4**: 60. 1884; Jepson, Fl. Calif. 392. 1914; Jepson, Man. Fl. Pl. Calif. 297. 1923.

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[29] **Chorizanthe angustifolia** Nutt. var. **Eastwoodae** Goodman, var. nov. Planta speciei similis sed floribus 2.5–3 mm. longis; staminibus 8–9.—Sandy soil, Morro Bay, San Luis Obispo County, California, May 16, 1928, *Eastwood 15108* (CAS TYPE).

*Chorizanthe pungens* Benth. var. *nivea* Curran, Bull. Cal. Acad. Sci. 1: 274. 1885; Jepson, Fl. Calif. 392. 1914.

*Chorizanthe nivea* (Curran) Jepson, Man. Fl. Pl. Calif. 297. 1923.

*Chorizanthe Andersoni* Parry, Proc. Davenp. Acad. Sci. 5: 175. 1889; Greene, Fl. Francis. 156. 1891; Jepson, Fl. Calif. 392. 1914, in synonymy.

Decumbent to ascending plants; stems several from the base, 1–2.5 dm. long, grayish with spreading or ascending pubescence; leaves basal, petiolate, oblanceolate, 2–4.5 cm. long, thickly short-villous beneath, at least when young, and sparsely villous above; bracts opposite, prevailingly acerose; involucres 3 mm. long, disposed in clusters in subequally branched cymes, the involucral tube triangular in cross-section, 2 mm. long, sparsely villous-hirsute with widely spreading hairs, the 6 teeth spreading and uncinate, the alternating 3 considerably shorter, all margined by a conspicuous, white membrane, this parted at the sinuses; flower partially exserted, subcylindric, about 2.5 mm. long, lobes similar, oblong, the apices acutish, entire or nearly so, 0.5 mm. long; stamens 9, anthers suborbicular to oval.

Type: in dry, sandy places near Monterey, California, 1848, *Hartweg 1938* (K).

Distribution: San Mateo and Santa Clara Counties southward to Santa Barbara County, California.

Specimens examined:

CALIFORNIA: SAN MATEO COUNTY—Jasper Ridge, May 29, 1910, *Dudley* (D); SANTA CLARA COUNTY—Jasper Ridge, May, 1901, *Abrams 1653* (D); SANTA CRUZ COUNTY—near Fulton, August, 1883, *Parry* (M); Ben Lomond, 1888, *Parry* $21^{2}$ (Par TYPE of *C. Andersoni*, US); Ben Lomond, June 28, 1888, *Parry* (M); Big Basin, June 7, 1895, *Dudley* (D); Santa Cruz, June 22, 1903, *Thompson* (D, M); sandy hills near Mt. Hermon, May 18, 1926, *Bacigalupi 1490* (D); Santa Cruz Mts., June 16, 1929, *Rowntree* (Pom); MONTEREY COUNTY—dry sandy places near Monterey, 1848, *Hartweg 1938* (K TYPE, M photograph, US photograph); Monterey, *Parry* (M, Par); Monterey, May 12, 1889, *Parry* (Par); near Seaside, May 19, 1903, *Heller 6750* (D, M, Ph, Pom, RMt, US); Monterey, June, 1903, *Elmer 5084a* (US); Carmel-by-the-Sea, April 30, 1910, *Randall 427* (D); Carmel River, August 15, 1910, *Clemens* (Pom); Seaside, May 29, 1912, *Eastwood 151* (CAS); near Monterey, June 26, 1923, *Peirson 8665* (Pe); near Del Monte, June 27, 1927, *Heller 14404* (M, Ph); SAN LUIS OBISPO COUNTY—Arroya Grande hills, July, 1883, *Summers 1* (US); mountain near San Luis Obispo, July, 1885, *Curran* (D, Par, Pom isotypes of *C. pungens* var. *nivea*); Price Cañon, *Brandegee 85* (D, M, Pom, RMt, US); SANTA BARBARA COUNTY—dry ridge, head of Purissima Canyon, March 26, 1925, *Munz 9275* (Pom); near Buellton, May 30, 1929, *Hoffmann* (E).

Despite the confusion that has existed concerning this species, it is well marked both as to aspect and technical characters. Obviously a member of the Pungentes subsection because of the involucral margins, it is unique in the lack (except in very young specimens) of foliaceous bracts. The broad, white involucral membrane makes the clusters of involucres almost showy for the genus. The perianths, which when fresh frequently have yellow-tipped lobes and a white tube, are distinctive by the acutish, very nearly entire segments.

Dr. Jepson recognizes Mrs. Curran's *C. pungens* Benth. var. *nivea* as a species, and designates these specimens from the southern portion of the range as erect. In the original description of var. *nivea,* Mrs. Curran stated that it was "decumbent," and such a characterization certainly applies correctly to the type collection. Herbarium material would indicate that the plants which are "erect" are but young specimens of *diffusa.*

### 12. **Chorizanthe Howellii** Goodman, n. sp.[30]

Pl. 3, fig. 1.

Spreading to decumbent plants; stems several from the base, thick, 1–2 dm. long, ascending villous; leaves basal, petiolate, spathulate to broadly obovate, 3–5 cm. long, gray villous-hirsute beneath, more sparsely villous above; bracts opposite, similar to the leaves, or the upper much reduced; involucres 5–6 mm. long, disposed in dense clusters, these 2–3 cm. broad, the involucral tube subcylindric, 3 mm. long, ascending villous between the ribs, teeth spreading, the spines straight, the 3 alternate a little shorter, all margined with a membrane, this parted at the sinuses; flower slightly exserted, subcylindric, 4 mm. long, outer lobes a little over 1 mm. long, inner 0.25 mm. shorter, all oblong, truncate, and denticulate at apices; stamens 9, anthers oval; achene 3.5 mm. long.

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[30] **Chorizanthe Howellii** Goodman, sp. nov. Planta patula vel decumbens; caulibus pluribus e base, crassis, 1–2 dm. longis, adscendente villosis; foliis basalibus, petiolatis, spathulatis vel late obovatis, 3–5 cm. longis, subter cinereo-villoso-hirsutis, supra sparse villosis; bracteis oppositis, similibus foliis aut superioribus multum minoribus; involucris 5–6 mm. longis, in glomerulis densis 2–3 cm. latis dispositis, tubo involucri subcylindrico, 3 mm. longo, inter costas adscendente villoso, dentibus patulis, spinis rectis, 3 alternatis brevioribus, omnibus membrana marginatis, ad sinus divisis; floribus paulo exsertis, subcylindricis, 4 mm. longis, lobis exterioribus circiter 1 mm. longis, interioribus 0.25 mm. brevioribus, omnibus oblongis, ad apices truncatis et denticulatis; staminibus 9, antheris ovalibus; achaeniis 3.5 mm. longis.—Sand dunes on Mendocino coastal plain, Ft. Bragg, Mendocino County, California, alt. 50 ft., May 26, 1929, *J. T. Howell 4233* (CAS TYPE).

Type: sand dunes on Mendocino coastal plain, Ft. Bragg, Mendocino County, California, alt. 50 ft., May 26, 1929, *J. T. Howell 4233* (CAS).

Distribution: Mendocino County, California.

Specimens examined:

CALIFORNIA: MENDOCINO COUNTY—sand dunes on Mendocino coastal plain, Fort Bragg, alt. 50 ft., May 26, 1929, *Howell 4233* (CAS TYPE, M photograph); on the beach, Fort Bragg, July, 1931, *Hutchinson* (M); Fort Bragg, July 12, 1931, *Jones 28863* (M).

*C. Howellii* is the most northern of the close relatives of *C. pungens.* Its nearest relative is *C. villosa,* from which it can be readily differentiated by the presence of marginal membranes on the involucres, and by the broadly spathulate leaves and bracts.

It is a pleasure to dedicate this species to John Thomas Howell, Assistant Curator of the Herbarium of the California Academy of Sciences, important collector of Pacific Coast plants, and friend who has conferred many favors upon the writer during the course of this study.

**13. Chorizanthe villosa** Eastwood, Bull. Torr. Bot. Club 30: 485. 1903; Jepson, Fl. Calif. 392. 1914, in synonymy.

Spreading plants; stems several from the base, slender, 2–4 dm. long, gray with spreading villous hairs; leaves basal or essentially so, petiolate, oblanceolate, 4 or 5 cm. long, villous; bracts opposite, similar to the leaves, reduced above; involucres 4 mm. long, in cymose clusters along the stems, the clusters about 1 cm. broad, the involucral tube more or less triangular in cross-section, 2.5 mm. long, shortly and rather densely and evenly villous with ascending hairs, the teeth divergent, the spines straight, marginal membrane obsolete; flower barely included, narrowly obconic, 3 mm. long, lobes about 0.75 mm. long, oblong, obtuse, mucronate, pubescent with hairs which often exceed the lobes; stamens 9, anthers oblong; mature achene slightly exserted.

Type: Bodega Point, Sonoma County, California, July 4, 1900, *Eastwood* (CAS).

Distribution: Sonoma and Marin Counties, California.

Specimens examined:

CALIFORNIA: SONOMA COUNTY—Bodega Point, July 4, 1900, *Eastwood* (CAS TYPE, M photograph, US); sand dunes, Bodega Point, June, 1905, *K. Brandegee* (M, Ph, Pom, RMt, US); Bodega Point, June 29, 1915, *Eastwood 4832* (CAS, US); MARIN COUNTY—Dillon's Beach, June 6, 1890, *Congdon* (D).

Of the specimens thus far seen of this species, the teeth of the involucres are an amber-yellow.

**14. Chorizanthe robusta** Parry, Proc. Davenp. Acad. Sci. 5: 176. 1889; Greene, Fl. Francis. 154. 1891; Greene, Man. Bot. Reg. San Francis. Bay, 49. 1894; Jepson, Fl. West. Mid. Calif. 150. 1901, and ed. 2. 129. 1911.

*Chorizanthe Douglasii* Parry, Proc. Davenp. Acad. Sci. 4: 56. 1884, not Benth.

*Chorizanthe pungens* Benth. var. *robusta* (Parry) Jepson, Fl. Calif. 392. 1914; Jepson, Man. Fl. Pl. Calif. 297. 1923.

Erect plants, 1.5–5 dm. tall; stem 1 or few from the base, thick, branched from the middle or near the bottom, spreading hirsute; leaves basal or nearly so, petiolate, the petiole frequently long and slender, oblanceolate, 4–8 cm. long, hirsute; bracts opposite or verticillate, similar to the leaves, the upper reduced; involucres long-campanulate, about 6 mm. long, arranged in large, dense, cymose clusters, these 2–4 cm. broad, the involucral tube subcylindric, 3.5–4 mm. long, evenly hirsute, teeth but slightly divergent, margined by an evident membrane, this parted at the sinuses, spines minute, straight or very shortly recurved to uncinate; flower included, shortly pedicellate, narrowly obconic, 3–4 mm. long, lobes oblong or slightly elliptic, rounded-erose, sometimes mucronate, 1–1.5 mm. long, subequal or the inner a little shorter; stamens 9, anthers linear-oblong, 0.5 mm. long.

Type: dry sandy soil, margins of Monterey Bay, north of Aptos, Santa Cruz County, California, June, 1883, *Parry* (Par.)

Distribution: Alameda and Santa Clara Counties, southward to Monterey County, California.

Specimens examined:

CALIFORNIA: ALAMEDA COUNTY—Alameda, July 4, 1866, *Bolander 1939* (M, US); Alameda, 1887, *Parry* (D); Alameda, 1888, *Parry 13*$^{2}$ (Par, US); Alameda, May, 1891, *Greene* (US); SANTA CLARA COUNTY—San Jose, 1882, *Parry* (M); SAN FRANCISCO COUNTY—Ocean View, June 11, 1889, *Congdon* (US); SAN MATEO COUNTY—Colma, June, 1905, *K. Brandegee* (D, RMt, US); SANTA CRUZ COUNTY—Santa Cruz, June 24, 1881, *Jones 2253* (M, Ph, Pom); Santa Cruz, June, 1883, *Parry* (M, Par); Aptos, June, 1883, *Parry* (CAS, Par TYPE); Santa Cruz, June 22, 1903, *C. H. Thompson* (M); near Watsonville, July 8, 1907, *Smith* (D); Santa Cruz, June 21, 1917, *Read* (CAS); salt marsh, near Watsonville, July 5, 1929, *Hayward* (D); MONTEREY COUNTY—Monterey, 1850, *Andrews 13 & 14* (ISC); near Soledad, June, 1881, *Congdon* (D); Salinas Valley; near Monterey Bay, June–July, 1889, *Abbott* (CAS); Del Monte, September, 1902, *Elmer 4047* (D, Pom); near Moss Landing, September 27, 1903, *Abrams 4047* (D); Carmel, August 22, 1909, *Abrams 4283* (D).

In many of its characters, *C. robusta* is quite as variable as *C. pungens*. In poorly developed specimens, the involucres are apt to be somewhat shorter than in the species, and sometimes the involucral teeth are spreading instead of divergent. Not infrequently the apiculations of the perianth lobes are present only on certain flowers of a plant, or only on certain lobes of a flower.

**15. Chorizanthe valida** Wats. Proc. Am. Acad. **12**: 271. 1877; Wats. Botany [of California] **2**: 36. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 57. 1884; Greene, Fl. Francis. 155. 1891; Greene, Man. Bot. Reg. San Francis. Bay, 49. 1894; Jepson, Fl. West. Mid. Calif. 150. 1901, and ed. 2. 129. 1911; Jepson, Fl. Calif. 394. 1914; Jepson, Man. Fl. Pl. Calif. 297. 1923.

Pl. 1, figs. 8–9.

Erect plants, 1–3 dm. tall; stem solitary, villous, only slightly branched; leaves basal or nearly so, petiolate, broadly oblanceolate, short-villous, or glabrate above; bracts foliaceous, similar to the leaves, upper acerose; inflorescence of large, dense, cymose, leafy bracted clusters of involucres, the clusters 2–3 cm. broad; involucres subcylindric, 5–6 mm. long, the tube 4 mm. long, finely cross-corrugated, scantily appressed-pubescent to glabrate, teeth erect or a little divergent, bordered by an inconspicuous membrane, spines straight, light-colored; flower cylindric, 5–6 mm. long, outer lobes oblong, truncate, erose to denticulate at apex, 1.75–2 mm. long, inner narrower and elliptic, 1–1.25 mm. shorter; stamens 9, the anthers linear-oblong, 1 mm. long.

Type: "Russian Colony" (G).

Distribution: Sonoma and Marin Counties, California.

Specimens examined:

CALIFORNIA: SONOMA COUNTY—*Samuels 194* (US); *Samuels 195* (US); MARIN COUNTY—Point Reyes, July, 1903, *Elmer 4756* (CAS, D, M, Pom, US).

Perhaps the most important morphologic modification to be found in this species is the greatly shortened inner perianth lobes. The erect, straight, light-colored involucral teeth are also unusual and serve well in making the species easily recognizable.

16. **Chorizanthe Douglasii** Benth. Trans. Linn. Soc. Lond. **17**: 418. 1836; Benth. in DC. Prodr. **14**: 25. 1857; Torr. & Gray, Proc. Am. Acad. **8**: 193. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 270. 1877; Wats. Botany [of California] **2**: 35. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 56. 1884, as to name only; Behr, Fl. Vicinity San Francis. 278. 1888, as to name only; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{1a}$: 11. 1891; Greene, Fl. Francis. 154. 1891; Jepson, Fl. West. Mid. Calif. 150. 1901, and ed. 2. 129. 1911, as to name only; Jepson, Fl. Calif. 392. 1914, as to name only; Jepson, Man. Fl. Pl. Calif. 297. 1923, as to name only.

*Chorizanthe Nortoni* Greene, Pittonia **2**: 164. 1891; Jepson, Fl. Calif. 391, *fig. 67b*. 1914; Jepson, Man. Fl. Pl. Calif. 296, *fig. 317*. 1923.

Erect plants, 1–3 dm. tall; stem solitary, branched above, curly ascending pubescent with a few spreading villous hairs; leaves basal, oblanceolate, narrowed to a short petiole, 2–5 cm. long, villous-hispid; bracts similar to the leaves, verticillate, frequently a medial, cauline whorl present, those subtending the involucres acerose; peduncles of the inflorescence umbellately arranged; involucres disposed terminally in dense, medium-sized, subspherical, cymose clusters, the involucral tube more or less triangular in cross-section, 2.5–3 mm. long, ascending hirsute, sometimes densely so, teeth shorter than the tube, bordered with a broad, purplish membrane, this continuous through the sinuses, not cleft or parted; flower obconic, about 3.5 mm. long, outer lobes obovate to oblong, cuneate, truncate to retuse, denticulate, apiculate by the excurrent midrib, about 1 mm. long, inner a little shorter, obovate, emarginate; stamens 9, anthers linear-oblong.

Type: California, coll. of 1833, *Douglas* (K).

Distribution: San Benito, Monterey, and San Luis Obispo Counties, California.

Specimens examined:

CALIFORNIA: SAN BENITO COUNTY—San Benito River, near Merrill Valley, alt. 1900 ft., May 24, 1915, *Hall 9922* (US); San Benito, May 16, 1918, *Eastwood 6948* (CAS, US); The Pinnacles, May 31, 1920, *Sutliffe* (CAS); Pinnacles, May 15, 1929, *Dr. & Mrs. Linsdale* (CAS); MONTEREY COUNTY—1833, *Douglas* (K TYPE, M fragment and photograph, Par fragment, US photograph); Soledad, June, 1881, *Congdon* (D); Salinas River, June, 1889, *Brandegee* (Pom); Palisades and Chalone Peaks near Gonzales, alt. 2000–4000 ft., May, 1891, *Norton* (CAS, D, M photograph of *C. Nortoni*); June, 1891, *Norton* (CAS, D, US); near Mission, May 11, 1895, *Dudley* (D); Stony Creek, San Migueleta Ranch, Santa Lucia Mts., May 1–12, 1897, *Eastwood* (US); Santa Lucia Mts., June, 1898, *Plaskett 157* (US); Tassajara Hot Springs, June, 1901, *Elmer 3253* (D, M, US); Carmel Valley, June 25, 1905, *Dudley* (D); Carmel River, July 1, 1906, *McMurphy* (D); Burro Trail, Santa Lucia Mts., June 9, 1909, *K. Brandegee* (US); Carmel River, August 15, 1910, *Clemens* (Pom); Tassajara Springs, July, 1916, *Kelly* (CAS); ''Big Pinnacles,'' April 27, 1919, *Ferris 1696* (D); Sur Ridge, Santa Lucia Mts., May 13, 1920, *Abrams 7443* (D); Rancho del Monte, Carmel River, May 7, 1921, *Mason* (D, US); cañon of Cachagua Creek, below Tassajara, May, 1926, *C. Dudley* (D); Tassajara Springs, May 30, 1926, *Durbrow* (CAS); pine woods, Santa Lucia Mts., alt. 4720 ft., June 27, 1929, *Rowntree* (E); Arroyo Seco Road, June 28, 1929, *Rowntree* (Pom); 20.5 miles west of King City, Santa Lucia Mts., May 23, 1931, *Howell 6516* (CAS, M); alt. 1900 ft., *Clemens* (US); SAN LUIS OBISPO COUNTY—Camp 27, Atascadero Ranch, May 1, 1861, *Brewer* (US); Camp 27, Atascadero Ranch, April 30, 1861, *Brewer 893* (US); Santa Margarita, May 11, 1933, *Wall* (CAS).

The identity of this species for the last several years has been essentially lost, and Greene's name, *Nortoni,* applied to it. *C. Douglasii* is very readily recognized by the funnel-like upper part of the involucres which is formed by the broad, usually purple, marginal membrane. Unlike the other species, here this membrane is not cleft in the sinuses but extends almost directly from tooth to tooth.

The medial whorl of cauline bracts and the umbellate arrangement of the peduncles is remindful of the morphology of *Eriogonum heracleoides*.

**17. Chorizanthe stellulata** Benth. Pl. Hartweg. 333. 1857; Benth. in DC. Prodr. **14**: 26. 1857; Torr. & Gray, Proc. Am. Acad. **8**: 193. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 270. 1877; Wats. Botany [of California] **2**: 35, 481. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 56. 1884; Greene, Fl. Francis. 154. 1891; Jepson, Fl. Calif. 391. 1914; Jepson, Man. Fl. Pl. Calif. 296. 1923.

Erect plants, 1–2.5 dm. tall; stem solitary, slender, spreading hirsute; leaves basal, sessile or short-petiolate, lanceolate to oblanceolate, 1–2 cm. long, spreading hispid-hirsute; bracts similar to the leaves, verticillate, very commonly a medial cauline whorl present, upper acerose and hispid; inflorescence of terminal, solitary or umbellately arranged, dense cymose clusters of involucres; the involucres 4.5–5 mm. long, tube prominently 6-ribbed, slightly contracted at the throat, cross-corrugated, about 4 mm. long, pubescence of spreading, hispid hairs, these chiefly on the ribs, the 6 teeth similar, short, recurved or uncinate, united by a white membrane, this lobed, but extended through the sinuses; flower shortly pedicellate, included, subcylindric, 4–4.5 mm. long, outer segments broadly obovate, obcordate to bilobed, 2–2.5 mm. long, inner similar but a little narrower and shorter; stamens 9, anthers oblong, 0.75 mm. long.

Type: "Valley of the Sacramento," *Hartweg 1937* (K).

Distribution: inland in northern and central California.

Specimens examined:

CALIFORNIA: SHASTA COUNTY—near Redding, May 30, 1905, *Heller 7910a* (M, Ph, US); Anderson, May 27, 1915, *Smith* (CAS); BUTTE COUNTY—Dead Man's Grade, May, 1879, *Austin* (Pom); Chico, May, 1882, *Parry* (M, Par, US); Chico, 1887, *Parry* (M, Par); SUTTER COUNTY—Marysville Buttes, May 17, 1902, *Heller & Brown 5568* (D, M, Ph, Pom, US); LAKE COUNTY—volcanic sand flats, Kelseyville, June 8, 1929, *Blankinship* (M); ELDORADO COUNTY—1884, *Curran* (D); Simpson's Ranch, May 29, 1907, *K. Brandegee* (Pom); CALAVERAS COUNTY—Wallace, June 4, 1914, *McMurphy* (D); MADERA COUNTY—Raymond, May 8, 1900, *Congdon* (D); Raymond, May 8, 1925, *Eastwood 12558* (CAS, Pom); FRESNO COUNTY—June, 1881, *Parry 264* (Par); COUNTY NOT KNOWN—1853–1854, *Bigelow* (Ph, US); Sacramento Valley, 1882, *Parry* (US); Sweetwater Creek, May 29, 1907, *K. Brandegee* (Pom).

*C. stellulata* is the most aberrant member of the Pungentes, the bilobed perianth lobes and the hirsute pubescence being unusual. The inflorescence and continuous (though deeply lobed) margins of the involucres are suggestive of relationship with *C. Douglasii.* It is the only inland species of the subsection.

Subsection 2. STATICOIDEAE, new subsection. Erect or decumbent plants, the characteristic pubescence of the stems at first directed downward, and then abruptly appressed; leaves basal; bracts opposite or, rarely, some of the foliaceous ones verticillate. Involucres 6-ribbed, 6-toothed, the anterior a little longer, margins not membranous. Perianths scantily pubescent, lobes mostly entire, occasionally conspicuously fimbriate, outer longer than the inner. Stamens usually 9, inserted at the base of the perianth. Species 18–26, incl.

Range: Los Angeles County, California, and country immediately adjacent eastward, north through Kern and Monterey Counties, and south to Lower California.

**18. Chorizanthe staticoides** Benth. Trans. Linn. Soc. Lond. **17**: 418. 1836; Benth. in DC. Prodr. **14**: 25. 1857, excluding *C. discolor;* Torr. & Gray, Proc. Am. Acad. **8**: 195. 1870, in part, excluding *C. discolor* and Xantus collection; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 271. 1877, excluding plants from San Diego; Wats. Botany [of California] **2**: 37. 1880, excluding plants from San Diego; Parry, Proc. Davenp. Acad. Sci. **4**: 59. 1884, as to description in part, and excluding synonymy and part of range; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3$^{1a}$**: 12. 1891; Greene, Fl. Francis. 157. 1891; Hall, Univ. Calif. Publ. Bot. [Botanical Survey San Jacinto Mountain] **1**: 72. 1902, as to name only; Abrams, Fl. Los Angeles & Vicinity, 113. 1904, and ed. 2. 104. 1917; Jepson, Fl. Calif. 393.

1914, in part, excluding synonymy except *C. nudicaulis,* and not as to plants of "upper San Joaquin valley"; Davidson & Moxley, Fl. So. Calif. 113. 1923, as to part of range; Jepson, Man. Fl. Pl. Calif. 297. 1923, as to coastal plants and including variety; Millspaugh & Nuttall, Publ. Field Mus. Nat. Hist. Bot. [Fl. Santa Catalina Island] 5: 83. 1923.

Pl. 1, figs. 6–7.

*Chorizanthe staticoides* Benth. var. *nudicaule* (Nutt.) Jepson, Fl. Calif. 394. 1914; Jepson, Man. Fl. Pl. Calif. 297. 1923.

*Chorizanthe nudicaulis* Nutt. Jour. Acad. Phila. N. S. 1: 166. 1848; Benth. Pl. Hartweg. 332. 1849, as to name only; Benth. in DC. Prodr. 14: 25. 1857, in synonymy; Torr. & Gray, Proc. Am. Acad. 8: 195. 1870, in synonymy; Davidson & Moxley, Fl. So. Calif. 113. 1923.

Erect plants, 1–3 dm. tall, reddish at maturity; stem 1 to several from the base, appressed pubescent, often trichotomously branched at the first node; leaves petiolate, oblanceolate, rounded and emarginate, 2-6 cm. long, tomentose beneath, curly pubescent above; bracts acerose; inflorescence a more or less flat-topped cyme, the involucres aggregated in dense clusters; involucres subcylindric or sometimes contracted above the middle, 3.5–4 mm. or more long, curly pubescent, the teeth spreading and the spines uncinate, the alternate 3 teeth much shorter; flower obconic, about 4 mm. long, outer lobes oblong to elliptic, obtuse, nearly as long as the tube, inner a half to two-thirds as long and narrower; stamens 9, anthers oblong-orbicular.

Type: "Nova California," coll. of 1833, *Douglas* (K).

Distribution: coastal from Monterey County southward to Orange County, California.

Specimens examined:

CALIFORNIA: MONTEREY COUNTY—mountains behind Monterey, September, 1877, *Hooker & Gray* (G); Monterey, 1877, *Hooker & Gray* (G); Tassajara Hot Springs, June, 1901, *Elmer 3251* (D, M, US); Burro Trail, Santa Lucia Mts., June 9, 1909, *K. Brandegee* (D, M, RMt, US); Tassajara Springs, June 1, 1917, *Kelley* (CAS); SAN LUIS OBISPO COUNTY—dry hill, Arroyo Grande, 1860–1862, *Brewer 445* (G, US); Santa Barbara, *Gambel* (M photograph, Ph TYPE of *C. nudicaulis*); 1865, *Torrey 433* (G, US); Santa Barbara, 1874, *Monks 36* (Ph); Hot Springs, June 5, 1896, *Dudley* (D); Santa Barbara, August 21, 1904, *Abrams 4116* (D, Pom); Blochman's Ranch, June 17, 1906, *Eastwood 459* (CAS, US); Zaca Lake Forest Reserve, June 19-30, 1906, *Eastwood 658* (CAS); Painted Cave Ranch, May 9, 1908, *Eastwood 107* (US); SAN BERNARDINO COUNTY—San Bernardino, 1876, *Parry* (G); 1876, *Parry & Lemmon 369* (CAS, M, Par); near San Bernardino, 1880, *Parish* (M); foothills of San Bernardino Mts., May 1, 1885, *Parish Bros. 667* (D, US); San Bernardino Mts., alt. 2500 ft., June 13, 1894, *Parish 3217* (US); dry mesas, alt. about 300 m., San Bernardino Valley, June 2, 1919, *Parish 19294* (CAS, D, G); RIVERSIDE COUNTY—Glen Ivy Trail to Santiago Peak, Santa Ana Mts., alt. 3700 ft., June 14, 1923, *Munz & Keck 7066* (Pom, RMt); LOS ANGELES COUNTY—North Fork San Gabriel, alt. 500 m., May 5, 1878, *Leiberg 3381a* (US); Los Angeles, 1884, *Nevin 18* (G); Santa Catalina Island, 1885, *Lyon* (G); June, 1887, *Parish 1999* (D, Par); June, 1888, *Hasse* (ISC); Newhall, June 3, 1893, *Hasse* (D); dry upland slopes, Avalon, Santa Catalina Island, June, 1897, *Trask* (M, US); hills near Inglewood, April, 1899, *Abrams 205* (D); Garvanza, April 8, 1900, *Grant* (D); Santa Monica Mts., alt. 800 ft., April 3, 1901, *Abrams 1274* (D, Pom); San Jose Hills, near Claremont, alt. 900 ft., April 5, 1901, *Parish 594* (D); Laurel Cañon, April 7, 1901, *Grant* (D); dry ground, May, 1901, *Grant* (ISC); Oak Knoll, May 5, 1901, *Braunton 15* (US); Glendora, May 5, 1902, *Braunton* (D); Glendora, May 5, 1902, *Braunton 306* (US); Glendora, May 14, 1902, *Grant* (D); Sherman, May 27, 1902, *Braunton 275* (US); Elysian Park, June 1, 1902, *Braunton 418* (US); Sepulveda Canyon, Santa Monica Mts., June 16, 1902, *Abrams 2554* (D, G, M, Ph, Pom, US); dry hillsides, Sierra Madre, July 2, 1902, *Abrams 2637* (D, G, M, Pom); Garvanza, May, 1903, *Sheldon* (E); hills near Claremont, May, 1904, *Baker 4706* (M, Pom, US); Altadena, June 17, 1904, *Grant* (D); Pasadena, June 17, 1904, *Grant 169* (CAS, D, M, Ph, Pom, RMt); Pasadena, May 18, *Grant 3887* (D); Tujunga Wash, July 6, 1905, *Grinnell 497* (US); Garvanza, May 27–June 10, 1906, *Eastwood 10* (CAS, US); Roscoe, June 5, 1906, *Eastwood 245* (CAS); Claremont Wash, May 25, 1910, *Davis 51* (M); San Fernando Wash, May 11, 1913, *Eastwood 3144* (CAS); dry roadside, Azusa, June 22, 1915, *Macbride & Payson 717* (G, RMt); rocky hillside, Griffith Park, July 12, 1915, *Macbride & Payson 815* (G, RMt); near Acton, June 12, 1918, *Ferris 953* (D); gravelly wash, near Claremont, May 14, 1919, *Munz 2791* (D, Pom); Sepulveda Canyon, Santa Monica Mts., alt. 800 ft., May 15, 1920, *Munz & Harwood 3924* (D, Ph, Pom, RMt), Mt. Wilson, June, 1921, *Blazic* (CAS); Griffith Park, May 15, 1925, *C. & M. Epling* (M); Sevaine Flats, San Antonio Mts., alt. 3000 ft., July 10, 1925, *Johnston* (Pom); mountains near Claremont, May 21, 1926, *Jones* (CAS, D, US); Mandeville Canyon, alt. 200–1000 ft., April 20, 1928, *Bryan 76* (Pom); dry ridge, Little Santa Anita Canyon, alt. 2100 ft., May 30, 1928, *Ewan 1526* (E); Little Santa Anita Canyon, alt. 1600 ft., May 30, 1928, *Ewan 1527* (E); Claremont, June 15, 1928, *Eastwood 15379* (CAS); Santa Monica Mts., alt. 1825 ft., May 25, 1929, *Ewan 1509* (E); hills along Ridge Route at Sandberg's, June, 1929, *Clark* (CAS); Tuna Canyon above Roscoe, alt. 1000 ft., June 7, 1929, *MacFadden 8* (E); Glendale, alt. 1000 ft., June 8, 1929, *Fisher 142* (US); trail to Barley Flats, San Gabriel Mts., alt. 5000 ft., July 10, 1929, *Ewan 1507* (E); gravelly slope, Mint Canyon, May 19, 1930, *Hoffmann* (CAS, E); gravelly slope, near Castaic, May 19, 1930, *Hoffmann* (CAS, E); between Coldbrook and Pine Flats, San Gabriel Mts., June 28, 1930, *Crow* (E); Santa Susana Pass, May 29, 1931, *Howell* (Pe); Santa Susana Pass, May 29, 1931, *Howell 6585* (CAS); San Gabriel Wash, May 31, 1931, *Howell 6621* (CAS); San Gabriel Wash, May 31, 1931, *Howell 6621a* (CAS); Thompson Creek Dam near Claremont, alt. 1600 ft., May 27, 1932, *Wheeler 764* (M); dry decomposed granite bank, upper Topango Canyon, Santa Monica Mts., July 7, 1933, *Epling & Ewan 7599* (M); dry grassy ridges, east end of Barley Flats, San Gabriel Mts., alt. 5300 ft., July 23, 1933, *Dunn & Ewan 7838* (M); ORANGE COUNTY—Santiago, June, 1899, *Bowman* (D); Mt. Santiago, June, 1901, *Abrams 1807* (D, Pom); hills near Santa Ana, Spring, 1902, *Geis 542* (D); bluffs along shore, Laguna Beach, May 5, 1916, *Crawford* (M, Pom, US); southern Puente Hills in the Santa Ana Cañon, alt. 1600 ft., June 8, 1927, *Howell 2455* (CAS); southern Puente Hills, Santa Ana Cañon, alt. 750 ft., June 8, 1927, *Howell 2461* (CAS); COUNTY NOT KNOWN—1833, *Douglas* (G, K TYPE, M photograph, US photograph); Cassitas Pass, alt. 550 ft., July, 1875, *Rothrock 168* (G, US); 1881, *Parry* (M, US).

*C. staticoides* has been a troublesome species, and even as delimited above it is a variable one. Of the several specific names which have at one time or another been placed in synonymy under *C. staticoides,* the author thinks that but one, *C. nudicaulis* Nutt., can remain there. *C. nudicaulis* has been recognized by some authors in recent years, either specifically or varietally, on the ground that it possesses green stems and white flowers. These characters frequently attend young specimens of *C. staticoides.* Indeed, on somewhat older specimens, both reddish and green involucres and stems and both red and white flowers may be found on the same plant. These characters accredited to *C. nudicaulis* can certainly not be detected in the type collection.

The variation in the perianth lobes from oblong to elliptic seems to be of no significance, nor is the slight variation in length and degree of divergence of the involucral teeth. Variations of importance have been detected, however, and these are described below as subspecific entities.

**18a. Chorizanthe staticoides** Benth. forma **bracteata** Goodman, n. form.[31]

Lower bracts foliaceous and persistent. Otherwise as the species.

Type: Red Reef Canyon, Topatopa Mts., Ventura County,

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[31] **Chorizanthe staticoides** Benth. forma **bracteata** Goodman, forma nov., bracteis inferioribus foliaceis et persistentibus. Cetera speciei similis.—Red Reef Canyon, Topatopa Mts., Ventura County, California, alt. 2800–3500 ft., June 8, 1908, *Abrams & McGregor 146* (D TYPE).

California, alt. 2800-3500 ft., June 8, 1908, *Abrams & McGregor 146* (D).

Distribution: Ventura and Los Angeles Counties, California.

Specimens examined:

CALIFORNIA: VENTURA COUNTY—Santa Paula, 1887–1888, *Parry* (M, Par); Red Reef Canyon, Topatopa Mts., alt. 2800–3500 ft., June 8, 1908, *Abrams & McGregor 146* (D TYPE, G, M photograph, US); Camarilla, April 27, 1926, *Jones* (Pom); LOS ANGELES COUNTY—Los Tunas Cañon, Santa Monica Mts., May, 1901, *Abrams 1708* (D, Pom).

This form constitutes a minor entity, and gains recognition partly because it seems localized in the northwest portion of the center of distribution for the species.

**18b. Chorizanthe staticoides** Benth. var. **brevispina** Goodman, n. var.[32]

Stem usually 1 to few from the base; teeth of the involucre very short, consisting of hardly more than the short, recurved or uncinate spines. Otherwise as the species.

Type: sandy soil near Deer Park, Monrovia Canyon, San Gabriel Mts., Los Angeles County, California, June 10, 1928, *J. T. Howell 3876* (M).

Distribution: western San Bernardino County and Los Angeles County, California.

Specimens examined:

CALIFORNIA: SAN BERNARDINO COUNTY—City Creek road to Big Bear Lake, alt. 6000 ft., July 28–30, 1930, *Goodman & Hitchcock 1748* (M); LOS ANGELES COUNTY—north Fork San Gabriel, alt. 500 m., May 5, 1878, *Leiberg 3381b* (US); hills, Los Angeles, April 22, 1888, *Hasse* (M); May, 1901, *Grant 3887* (US); Mt. Lowe, July 24, 1901, *Williamson* (Ph); Pasadena, June 28, 1902, *Jones* (Pom); San Gabriel Wash, alt. 500 ft., May 13, 1917, *Johnston 27P* (Pom); Altadena, alt. 1500 ft., June 30, 1917, *Grinnell* (D); Barley Flats, San Gabriel Mts., alt. 5600 ft., July 8, 1917, *Grinnell* (D, Pom); San Gabriel Canyon, May 29, 1919, *Eastwood 8963* (CAS, G); Mt. Wilson, June 20, 1919, *Eastwood 9045* (CAS); San Gabriel Mts., alt. 3000 ft., June 30, 1924, *Dobbs* (Pe); San Antonio Mts., alt. 4700 ft., July 8, 1925, *Johnston* (Pom); Deer Park, Monrovia Canyon, San Gabriel Mts., June 10, 1928, *Howell 3876* (CAS, M TYPE); near Lake Hollywood, Santa Monica Mts., alt.

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[32] **Chorizanthe staticoides** Benth. var. **brevispina** Goodman, var. nov. caulibus solitariis aut paucis e base; involucri dentibus brevissimis, vix plus spinis brevibus recurvatis aut uncinatis. Cetera speciei similis.—Sandy soil near Deer Park, Monrovia Canyon, San Gabriel Mts., Los Angeles County, California, June 10, 1928, *J. T. Howell 3876* (M TYPE).

1000 ft., May 30, 1930, *Ewan 2244* (E, Po); gravelly ground, Tujunga Canyon, San Gabriel Mts., June 12, 1932, *Ewan 7365* (E); San Dimas Cañon, San Gabriel Mts., alt. 1800 ft., June 12, 1932, *Wheeler 821* (M); gravelly chaparral slope, Upper Millards Canyon, San Gabriel Mts., alt. 3700 ft., July 4, 1932, *Ewan 7586* (M).

**18c. Chorizanthe staticoides** Benth. var. **elata** Goodman, n. var.[33]

Erect plants; stems few from the base, 3.5–5 dm. tall; leaves petiolate, oblong to oblanceolate, obtuse to emarginate, 8–10 cm. long, thinly tomentose beneath, sparsely villous above; lower bracts frequently foliaceous, oblanceolate to lanceolate, upper much reduced; involucres in small clusters at the ends of the branches of a loose cyme, similar to those of the species; mature flowers not seen; stamens 9.

Type: dry ridge in chaparral belt, Glen Ivy trail to Santiago Peak, Santa Ana Mountains, Riverside County, California, alt. 4800 ft., June 14, 1923, *Munz 7085* (Pom.)

Distribution: western San Bernardino and Riverside Counties and westward, California.

Specimens examined:

CALIFORNIA: SAN BERNARDINO COUNTY—Arrowhead Hot Springs, alt. 1600 ft., May 7, 1919, *Spencer 1102* (CAS, Pom); RIVERSIDE COUNTY—dry ridge, Glen Ivy trail to Santiago Peak, Santa Ana Mts., alt. 4800 ft., June 14, 1923, *Munz 7085* (M photograph, Pom TYPE); LOS ANGELES COUNTY—dry hills, April 22, 1888, *Hasse* (US); San Dimas Canyon, alt. 1500 ft., April 21, 1920, *Munz & Harwood 3715* (Pom, RMt, US); San Dimas Canyon, alt. 1500 ft., May 2, 1920, *Munz & Harwood 3822* (Pom, US); Arroyo Seco, Pasadena, May, 1925, *C. & M. Epling* (M); Griffith Park, alt. 1050 ft., April 26, 1930, *Ewan 2252* (E).

No mature plants of this variety have been seen, and it may be found, upon the study of further collections, that this entity is a distinct species. However, in the lack of complete knowledge of the morphology of the plants, and because they do not have a separate range, nor, so far as collections now show, do they form an aspect of the range of the parent species, they are considered as constituting a variety.

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[33] **Chorizanthe staticoides** Benth. var. **elata** Goodman, var. nov. Planta erecta; caulibus paucis e base, 3.5–5 dm. altis; foliis petiolatis, oblongis vel oblanceolatis, obtusis vel emarginatis, 8–10 cm. longis, subter parce tomentosis, supra sparse villosis; bracteis inferioribus saepe foliaceis, oblanceolatis vel lanceolatis, superioribus multum minoribus; involucris in glomerulis parvis ad terminos ramorum cymae laxae, speciei similibus; floribus maturis non visis; staminibus 9.—Dry ridge in chaparral belt, Glen Ivy trail to Santiago Peak, Santa Ana Mountains, Riverside County, California, alt. 4800 ft., June 14, 1923, *Munz 7085* (Pom TYPE).

**18d. Chorizanthe staticoides** Benth. var. **latiloba** Goodman, n. var.[34]

Diffuse ascending plants; outer lobes of the perianth obovate and truncate, 2 mm. long, inner oblanceolate and truncate, about two-thirds as long. Otherwise as in the species.

Type: Acton, Los Angeles County, California, June, 1902, *Elmer 3689* (M).

Distribution: probably only from Los Angeles County, California.

Specimens examined:

CALIFORNIA: LOS ANGELES COUNTY—Rock Creek, June, 1886, *Parish 1986* (D, Par); San Francisquito Cañon, June, 1887, *Parish Bros. 1988* (M); San Francisquito Cañon, June, 1887, *Parish 1988* (D, Par); Acton, June, 1902, *Elmer 3689* (D, G, M TYPE, Pom, US); Newhall, May 15, 1916, *Evermann* (CAS); Mint Cañon, alt. 1500 ft., June 15, 1918, *Peirson 26* (Pe); Little Rock Creek, San Gabriel Mts., alt. 3500 ft., May 20, 1921, *Peirson 5342* (E, Pe); COUNTY NOT KNOWN—hills bordering Mojave Desert, May 24, 1882, *Pringle* (Ph); hills bordering Mojave Desert, May 25, 1882, *Pringle* (Ph, US).

**19. Chorizanthe chrysacantha** Goodman, n. sp.[35]

Pl. 3, fig. 2.

Plants erect, 1–2 dm. tall; stems trichotomously branched at first node, canescent with appressed pubescence; leaves petiolate, oblong, obtuse to emarginate, 3–4 cm. long, tomentose beneath, pubescent to glabrate above; bracts small, subulate; inflorescence of a few large, dense cymose clusters; involucres subcylindric, about 5 mm. long, the tube 4 mm. long, pubescent, sometimes cross-corrugated, the teeth divergent, the short spines down-curved to uncinate; flower cylindric, 5–5.5 mm. long, outer lobes broadly elliptic-ovate, very obtuse, over 2 mm. long, inner elliptic to oblong, 0.5 mm. shorter; stamens 9, anthers elliptic-oblong.

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[34] **Chorizanthe staticoides** Benth. var. **latiloba** Goodman, var. nov. Planta diffusa vel adscendens; perigonii laciniis exterioribus obovatis et truncatis, 2 mm. longis, 1½ plo longioribus quam interioribus, interioribus oblanceolatis et truncatis. Cetera speciei similis.—Acton, Los Angeles County, California, June, 1902, *Elmer 3689* (M TYPE).

[35] **Chorizanthe chrysacantha** Goodman, sp. nov. Planta erecta, 1–2 dm. alta; caulibus ad primum nodum trichotome ramosis, canescentibus, appressa pubescentia; foliis petiolatis, oblongis, obtusis vel emarginatis, 3–4 cm. longis, subter tomentosis, supra pubescentibus vel glabris; bracteis parvis, subulatis; inflorescentia in glomerulis paucis magnis densis disposita; involucris subcylindricis, circiter 5 mm. longis, tubo 4 mm. longo, pubescente, interdum transverso-corrugato, dentibus divergentibus, spinis brevibus recurvatis vel uncinatis; floribus cylindricis, 5–5.5 mm. longis, lobis exterioribus late elliptico-ovatis, obtusissimis, plus 2 mm. longis, interioribus ellipticis vel oblongis, 0.5 mm. brevioribus; staminibus 9, antheris elliptico-oblongis.—Bluffs along coast, Laguna Beach, Orange County, California, alt. 50 ft., April 17, 1920, *Munz & Harwood 3775* (Pom TYPE).

Type: bluffs along coast, Laguna Beach, Orange County, California, alt. 50 ft., April 17, 1920, *Munz & Harwood 3775* (Pom).

Distribution: known only from Orange County, California.

Specimens examined:

CALIFORNIA: ORANGE COUNTY—bluffs along coast, Laguna Beach, alt. 50 ft., April 17, 1920, *Munz & Harwood 3775* (M photograph, Pom TYPE); on sea bluffs, Laguna, May 31, 1924, *Peirson 4644* (Pe); COUNTY NOT KNOWN—"sea side form," April, 1881, *Parry 271* (G).

The range of this species, it will be noticed, lies just to the south of that of its relative, *C. staticoides*. The size of the involucres in the large dense clusters makes the species easily recognizable. Except at late maturity, the involucral teeth are golden or amber-yellow.

**19a. Chorizanthe chrysacantha** Goodman var. **compacta** Goodman, n. var.[36]

Stems more numerously branched, densely pubescent; the dense clusters of involucres closely aggregated; involucral teeth very short. Otherwise similar to the species.

Type: Bench Bluff, between Laguna and Newport, Orange County, California, April 27, 1928, *Reed 5700* (Pom.)

Distribution: known only from Orange County, California.

Specimens examined:

CALIFORNIA: ORANGE COUNTY—Bench Bluff, between Laguna and Newport, April 27, 1928, *Reed 5700* (M photograph, Pom TYPE).

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[36] **Chorizanthe chrysacantha** Goodman var. **compacta** Goodman, var. nov., caulibus numerosius ramosis quam in specie, dense pubescentibus; involucris in glomerulis densis aggregatis, involucri dentibus brevissimis. Cetera speciei similis.—Bench Bluff, between Laguna and Newport, Orange County, California, April 27, 1928, *Reed 5700* (Pom TYPE).

The compact habit, resulting from short internodes and the more frequently branched stems, gives the variety a very different appearance than the species.

**20. Chorizanthe Xanti** Wats. Proc. Am. Acad. **12**: 272. 1877; Wats. Botany [of California] **2**: 37, 481. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 59. 1884; Greene, Fl. Francis. 157. 1891; Abrams, Fl. Los Angeles & Vicinity, 114. 1904, except as to stated range; Jepson, Fl. Calif. 394. 1914, in synonymy.

Ascending to spreading plants, branched at or near the base; stems 0.5–3 dm. long, gray-pubescent, sometimes sparsely so; leaves petiolate, broadly ovate to oblong, 2–5 cm. long, tomentose beneath, short-villous above; lower bracts foliaceous, similar to the leaves, or lanceolate, upper acerose; inflorescence of congested, more or less flat-topped cymes, the involucres appearing singly in the axils or in small clusters; involucres 4.5–6 mm. long, the tube cylindric, about 4 mm. long, densely pubescent, the teeth widely divergent, the anterior tooth not detectably longer, the spines recurved to uncinate; flower subcylindric, 5–6 mm. long, outer lobes oblong-linear to elliptic, 2 mm. or more long, inner linear-oblong, a little shorter; stamens 9, anthers short-oblong.

Type: near Fort Tejon, Kern County, California, "*C. L. Xantus*" (G).

Distribution: Kern County to Riverside County, California, and adjacent counties to the westward.

Specimens examined:

CALIFORNIA: KERN COUNTY—Fort Tejon and vicinity, 1857–1858, *Xantus de Vesey* (US isotype); in Owens Valley and at Fort Tejon, 1863, *Horn* (US); Tehachipi, May, 1883, *Parry* (M); Fort Tejon, June, 1887, *Parish 1989* (D, Par); near Caliente, alt. 800–1100 m., June 24, 1891, *Coville & Funston 1100* (D, US); Bakersfield, May 2, 1896, *Davy 1882* (RMt); Tejon Pass, June 16, 1896, *Dudley & Lamb 4556* (US); Keene, alt. 1700 ft., May 22, 1903, *Jones* (Pom.); Bakersfield, May 23, 1903, *Jones* (Pom); east slope of Greenhorn Range, alt. 4000 ft., June 2–10, 1904, *Hall & Babcock 5081* (D); McKittrick, April 29, 1905, *Heller 7797* (D, M, Ph, US); Johnson Canyon, Walker Basin, June 5, 1905, *Grinnell 110* (US); near Havilah, June 11, 1905, *Grinnell 194* (US); near Havilah, June 15, 1905, *Grinnell 288* (US); vicinity of Fort Tejon, alt. 3200 ft., June 16–17, 1908, *Abrams & McGregor 305* (D); hills, Bakersfield, alt. 2000 ft., May 25, 1926, *Ford* (D); Tehachapi Mts., June 1, 1926, *Weston 164* (CAS); gravelly slope, Frazier Mountain Park, May 25, 1928, *Hoffmann* (Pom); dry slopes, Tehachapi Grade, alt. 1000 ft., May 17, 1929, *Munz 11426* (Pom); dry hills, Caliente, April 28, 1930, *Hoffmann* (CAS); rocky slope, near Kernville, alt. 2770 ft., May 13, 1930, *Howell 5034* (CAS); SAN BERNARDINO COUNTY—San Bernardino, 1876, *Parry* (M); 1876, *Parry & Lemmon 368* (CAS, M, Ph, US); April, 1876, *Lemmon* (US); San Bernardino, May, 1885, *Parish 367* (US); mouth of Santa Ana Cañon, San Bernardino Mts., May 1, 1885, *Parish 601* (D); San Bernardino, May 1, 1885, *Parish 638* (US); Yucaipe, San Bernardino Mts., alt. 2500 ft., June 13, 1894, *Parish 3217a* (US); vicinity of San Bernardino, alt. 500 ft., May 11, 1901, *Parish 4771* (D, US); Palm Cañon, Palm Springs, April 30, 1913, *Eastwood 3100* (CAS); Lytle Creek, San Gabriel Mts., alt. 5000 ft., July 18, 1921, *Peirson 2501* (Pe); RIVERSIDE COUNTY—San Gorgonio, *Parry* (Par); SAN LUIS OBISPO COUNTY—on Cuyama Valley Road, about 62 miles east of the Coast Boulevard, May 18, 1929, *Peirson 8402* (Pe); SANTA BARBARA COUNTY—Carpinteria, April 6, 1929, *Jones* (Pom); VENTURA COUNTY—valley below Cuddys, Mt. Pinos region, June 15–16, 1896, *Dudley & Lamb 4556* (D, Pom); LOS ANGELES COUNTY—Los Angeles, 1881, *Parry* (M); Elizabeth Lake, July 2, 1905, *Grinnell 450* (US); Lone Pine Cañon, San Antonio Mts., alt. 3500 ft., May 30, 1921, *Peirson 2419* (Pe, Pom); Lone Pine Canyon, alt. 5000 ft., June 17, 1921, *Munz 4654* (Pom); sandy slope, Elizabeth Lake, May 22, 1929, *Hoffmann* (E); gravelly soil, trail to Barley Flats, San Gabriel Mts., alt. 4800 ft., July 10, 1929, *Ewan 1506* (E); COUNTY NOT KNOWN—hills bordering on the Mojave Desert, May 25, 1882, *Pringle* (US); 1883, *Parry* (M, US); North Fork of Kern River, alt. 750 m., June 22, 1931, *Coville & Funston 1033* (US); sunny slopes, Erskin Creek, alt. 4000–5000 ft., April–September, 1897, *Purpus 5027* (M, US.)

As will be noticed from the description, *C. Xanti* has several characters which separate it from related species. The ovate leaves constitute an excellent character, although these are sometimes lacking in herbarium specimens. The foliaceous bracts and the usually white-pubescent and long involucres are characteristic. Further, the inflorescence of *C. Xanti* does not consist of dense, spherical clusters of involucres, but rather of conglomerate cymes composed of groups of 1 to few, erect involucres.

**20a. Chorizanthe Xanti** Wats. var. **leucotheca** Goodman, n. var.[37]

Smaller plants; the involucres white-tomentose. Otherwise as the species.

Type: Whitewater, Riverside County, California, May 11, 1903, *Jones* (Hb. Pom. College 122122).

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[37] **Chorizanthe Xanti** Wats. var. **leucotheca** Goodman, var. nov. Planta speciei similis sed brevior; involucris albo-tomentosis.—Whitewater, Riverside County, California, May 11, 1903, *Jones* (Hb. Pom. College 122122 TYPE).

Distribution: western San Bernardino and Riverside Counties, California, and possibly adjacent counties to the westward.

Specimens examined:

CALIFORNIA: SAN BERNARDINO COUNTY—Lytle Creek, San Gabriel Mts., alt. 3500 ft., May 18, 1920, *Peirson 1772* (CAS, Pe); RIVERSIDE COUNTY—near Cabazon, April, 1891, *Orcutt* (M); Whitewater, May 11, 1903, *Jones* (M photograph, Pom 122122 TYPE); Palm Spring, alt. 2000 m., April 19, 1906, *Parish 6168* (D); Whitewater, April, 1914, *Peirson 1776* (Pe); Snow Creek, alt. 1000 ft., April 10, 1922, *Jaeger* (D); Mission Creek Wash, April 15, 1926, *Jaeger* (Pom); Whitewater Canyon, alt. 1500 ft., Spring, 1929, *Clary* (E); dry flat, near Cabazon, May 1, 1930, *Munz 11919* (Pom.)

The writer is particularly indebted to Mr. J. A. Ewan, of Los Angeles, for additional material of this variety. Mr. Ewan had also detected this new variety and was preparing to publish on it when he heard that the group was undergoing revisional treatment, whereupon he placed his entire collection of the genus in the hands of the writer.

**21. Chorizanthe leptotheca** Goodman, n. sp.[38]

*Chorizanthe staticoides* Benth. acc. to Hall, Univ. Calif. Publ. Bot. [Botanical Survey San Jacinto Mountain] **1**: 72. 1902, and of several other authors in part.

Erect to diffuse reddish plants, stem 1 to several from the base, slender, 1–2 dm. long, scantily pubescent; leaves slender-petiolate, obovate to oblong or oblanceolate, 2–4 cm. long, the blades sometimes but a few millimeters long, tomentose beneath, villous above; upper bracts acerose; inflorescence a rounded, loose cyme, the involucres in small, loose clusters; involucres slender, 4 mm. long, tube nearly as long, curly pubescent, the teeth spreading and uncinate; flower well exserted, perianth cylindric, 4.5–5 mm. long, tube about 3 mm. long, outer lobes linear, obtuse, inner linear-lanceolate, scarcely more than half as long; stamens 9, anthers oblong-orbicular.

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[38] **Chorizanthe leptotheca** Goodman, sp. nov. Planta erecta vel diffusa, rosea; caulibus solitariis vel pluribus e base, 1–2 dm. longis, sparse pubescentibus; foliis tenui-petiolatis, obovatis vel oblongis vel oblanceolatis, 2–4 cm. longis, laminis interdum modo paucis millimetribus longis, subter tomentosis, supra villosis; bracteis superioribus acerosis; inflorescentia cyma rotundata laxa; involucris tenuibus, 4 mm. longis, in glomerulis parvis laxis, tubum paulo superantibus, crispopubescentibus, dentibus patulis et uncinatis; floribus valde exsertis, cylindricis, 4.5–5 mm. longis, tubo circiter 3 mm. longo, lobis exterioribus linearibus, obtusis, interioribus lineari-lanceolatis, vix plus ½ longitudine; staminibus 9, antheris oblongo-orbicularibus.—Dry hills between Ramona and Ballena, San Diego County California, June 19, 1903, *Abrams 3777* (M TYPE).

Type: dry hills between Ramona and Ballena, San Diego County, California, June 19, 1903, *Abrams 3777* (M).

Distribution: western Riverside County, California, southward into Lower California.

Specimens examined:

CALIFORNIA: RIVERSIDE COUNTY—San Jacinto Mt., alt. 5000 ft., July 29, 1897, *Hall 745* (US); Elsinore, May, 1901, *Mrs. J. D. Abrams* (D); San Jacinto, alt. 1800 ft., May 28, 1921, *Spencer 1716* (G); MacMullen Trail, San Jacinto Mts., June 14, 1921, *Spencer 1715* (G); MacMullen Trail, San Jacinto Mts., June 14, 1922, *Jaeger* (D, US); near Idyllwild, San Jacinto Mts., alt. 6000 ft., June 24, 1922, *Spencer 1975* (Pom); dry slopes, Aguanga Valley, May 20, 1925, *Munz 9843* (Pom); Aguanga, May 20, 1925, *Peirson 6012* (Pe); dry slope, near Coahuila, May 21, 1927, *Munz 10879* (Pom); dry sandy soil on road to Hemet, San Jacinto Mt., alt. about 4500 ft., August 2, 1927, *Howell 2926* (CAS); SAN DIEGO COUNTY—San Diego, May 1, 1862, *Cooper 523* (US); Valle de las Viejas, June, 1877, *Cleveland* (G); Campo, June, 1880, *Vasey 543* (US); Oak Grove, 1880, *Vasey 543a* (US); Witch Creek, June, 1894, *Alderson* (D, G); dry hills between Ramona and Ballena, June 19, 1903, *Abrams 3777* (D, G, M TYPE, Ph, Pom, US); Descanso, June, 1910, *K. Brandegee* (D, US); sandy hillsides, Descanso, alt. 3100 ft., July 22, 1918, *Spencer 1022* (G); sandy hills, Mesa Grande, alt. 3300 ft., May 24, 1919, *Spencer 1144* (CAS, Pom); near Santa Ysabel, June 29, 1923, *Munz & Harwood 7310* (Pom); Laguna Mt., May 22, 1927, *Sanford* (CAS).

LOWER CALIFORNIA: near U. S. Boundary Mts., July 2, 1884, *Orcutt* (M, Par, US); dry sandy slope, south of Tecate, May 12, 1925, *Munz 9481* (Pom).

It is probable that the lower bracts in this species are foliaceous but early caducous.

Specimens of *C. leptotheca* are recognizable by the loose inflorescence and the slender, red stems and involucres. Representatives of this species have heretofore passed as *C. staticoides* but the nearest relative is *C. Xanti*.

Orcutt's *1371* from Rosario, Lower California (hbb. Missouri Botanical Garden and Parry) differs from typical *C. leptotheca* in having crenate perianth lobes.

**22. Chorizanthe discolor** Nutt. Jour. Acad. Phila. N. S. **1**: 167. 1848; Benth. in DC. Prodr. **14**: 25. 1857, in synonymy; Torr. & Gray, Proc. Am. Acad. **8**: 195. 1870, in synonymy.

Ascending to spreading plants; stems few from the base, 1–1.5 dm. long, gray-pubescent; leaves petiolate, the blades oblong, rounded to truncate, emarginate, 1.5–3.5 cm. long, tomentose beneath, lanate to sparsely pubescent above; bracts linear to acerose; inflorescence of medium-sized, dense, cymose clusters; the involucres triangular in cross-section, 4–5 mm. long, the tube short, less than 3 mm. long, curly pubescent, the outer teeth long and spreading, spines straight except for the down-curved to uncinate tips, inner similar but half as long; mature flowers not seen; stamens 9, anthers short-oblong.

Type: "St. Diego," California, *Gambel* (Ph.)

Distribution: San Diego County, California.

Specimens examined:

CALIFORNIA: SAN DIEGO COUNTY—"St. Diego," *Gambel* (G isotype, M photograph, Ph TYPE); San Diego, 1882, *Parry* (M, Par); between Jacumba and Mountain Springs, April 24, 1920, *Eastwood* (CAS).

Probably the nearest relative of *C. discolor* is *C. staticoides,* from which it is separated readily both morphologically and geographically. The round, smaller clusters of involucres and the short involucral tube separate it well, and manifest a closer morphologic resemblance to *C. Breweri.*

An immature flower of *C. discolor,* which was but 2.5 mm. long, had broadly obovate-oblong outer lobes, and ovate-lanceolate inner lobes which were half as long.

**23. Chorizanthe Breweri** Wats. Proc. Am. Acad. **12**: 270. 1877; Wats. Botany [of California] **2**: 36. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 57. 1884; Greene, Fl. Francis. 155. 1891; Jepson, Fl. Calif. 393. 1914, excluding part of description; Jepson, Man. Fl. Pl. Calif. 297. 1923.

Ascending to decumbent plants; stems few from the base, 1–1.5 dm. long, gray-pubescent; leaves petiolate, blades spathulate to ovate and about 1 cm. long, short villous-pubescent; bracts similar to the leaves or the lamina orbicular, lanceolate or acerose; inflorescence of small, dense, rather remote cymose clusters; involucres subcylindric, 3–4 mm. long, tube nearly as long, pubescent, the teeth short and widely spreading, the short spines down-curved to uncinate; flower 3–3.5 mm. long, the outer lobes elliptic to broadly obovate-oblong, as long as the tube, inner ovate to orbicular-ovate, 0.5 mm. shorter; stamens 9, anthers oblong.

Type: dry rocky hillsides, San Luis Obispo, California, April, 1861, *Brewer 456* (G).

Distribution: San Luis Obispo County, California.

Specimens examined:

CALIFORNIA: SAN LUIS OBISPO COUNTY—dry, rocky hillsides, San Luis Obispo, April, 1861, *Brewer 456* (G TYPE, M photograph, US); San Margarita Valley, *Brewer 894* (G, Par); Atascadero Ranch, May 1, 1861, *Brewer 894* (M, US); San Luis Obispo, 1882, *Jones* (G, Par); San Luis Obispo, May, 1882, *Jones* (Ph); San Luis Obispo, May 6, 1882, *Jones 3234* (CAS, D, M, Pom, RMt, US); Chorro, May, 1909, *K. Brandegee* (US); Chorro Creek, May 17, 1928, *Eastwood 15116* (CAS); serpentine hills, along Chorro Creek, May 17, 1928, *Eastwood 15127* (CAS); on stony hills, near San Luis Obispo, May 19, 1928, *Eastwood 15167* (CAS).

This infrequently collected species seems to constitute a northern offshoot of *C. staticoides*, much as *C. discolor* represents a southern offshoot of the same parent.

The broadly foliaceous, sometimes nearly orbicular bracts of *C. Breweri* are very distinctive. Fortunately, these are fairly persistent.

The occurrence of the involucres in small clusters (1 cm. or less broad), the short appearance of the involucres, caused by the shortness of the teeth, and the short flowers with broad lobes are good diagnostic characters.

In Watson's revision, where the species was originally described, *C. Breweri* is placed near *C. pungens* because the teeth were "united at base by an inconspicuous margin." Such an interdentate margin occurs in all members of the subsection Staticoideae and in many members of subsequent subsections. This membrane does not show a relationship to the characteristic margin on the teeth of the subsection Pungentes. In *C. Breweri* the margin is a little larger than usual.

Variation in the shape of the perianth lobes occurs here much as it does in *C. staticoides*.

**24. Chorizanthe Wheeleri** Wats. Proc. Am. Acad. **12**: 272. 1877; Wats. Botany [of California] **2**: 38. 1880; Parry, Proc.

Davenp. Acad. Sci. **4**: 59. 1884, in synonymy; Greene, Fl. Francis. 157. 1891; Jepson, Fl. Calif. 394. 1914, in synonymy.

*Chorizanthe staticoides* Benth. acc. to Greene, Bull. Cal. Acad. Sci. [Bot. Santa Cruz Island] **2**: 411. 1887; T. S. Brandegee, Proc. Cal. Acad. Sci. [Fl. Santa Barbara Islands] II. **1**: 216. 1888.

*Chorizanthe insularis* Hoffmann, Bull. So. Cal. Acad. Sci. **31**: 56. 1932.

Erect to spreading plants; stems frequently trichotomously branched at first node, 0.6–2 dm. long, gray-pubescent; leaves petiolate, ovate-spathulate to oblong, 2–3 cm. long, tomentose beneath, short-villous above; foliaceous bracts lanceolate and cuspidate, opposite or occasionally 3 or 4 in a verticil, upper acerose; inflorescence of closely congested terminal clusters, 1–1.5 cm. broad, red at maturity; involucres cylindric, 2.5–3 mm. long, tube the same length, sparsely pubescent to glabrate, and also beset with a few short, thick, upwardly curved, blunt and transparent hairs, teeth short, widely spreading, spines very short, down-curved to uncinate; flower partially exserted, cylindric, 3–3.5 mm. long, lobes entire to subentire, sometimes divergent, outer elliptic-oblong to lanceolate and obtuse, 1.25–1.5 mm. long, inner oval or narrower, a little shorter; stamens 6, anthers oblong.

Type: Santa Barbara, California, July, 1875, *J. T. Rothrock 62* (G).

Distribution: Santa Barbara County, California—chiefly on the Santa Barbara Islands.

Specimens examined:

CALIFORNIA: SANTA BARBARA COUNTY—Santa Barbara, July, 1875, *Rothrock 62* (F, G TYPE, M photograph, Par fragment, US); Santa Barbara, 1929, *Hoffmann* (CAS); SANTA CRUZ ISLAND—June 6, 1918, *Miller* (CAS); Summer, 1919, *Swain* (CAS); about Prisoner's Cove, April 14, 1927, *M. B. Peirson* (Pe); canyon at Lady's Harbor, April 10, 1930, *Munz & Norris 11847* (Pom); near Pelican Bay, April 26, 1930, *Abrams & Wiggins 66* (CAS); stream bed above Cochies Prietos, July 1, 1930, *Hoffmann* (Pom); Canada del Puerta Zuela, April 10, 1931, *Howell 6220* (CAS); ½ mile northeast of Main Ranch, April 12, 1931, *Hoffmann* (M, US isotypes of *C. insularis*); Cochie Canyon, April 12, 1931, *Howell 6300* (CAS, Pe); SANTA ROSA ISLAND—Elder Creek, *Hoffmann* (CAS); dry slope of Water Canyon, April 8, 1930, *Munz & Crow 11679* (Pom).

The identity of *C. Wheeleri* has long been uncertain. The type, collected on the mainland of Santa Barbara County, is so scanty as likely to cause a botanist to consider its characters as aberrant rather than genetic. More ample collections from the Santa Barbara Islands revealed the distinctness of the island material and led to the publication of *C. insularis*. The present writer has been unable, after making careful comparison of the type of *Wheeleri* with the insular material, to separate them so much as varietally.

*Chorizanthe Wheeleri* furnishes another example of a flowering plant which is nearly extinct on the mainland, but is still plentiful on the neighboring islands.

Besides the macroscopic characters which make the species recognizable, there are two technical characters which can aid in identifying fragmentary material. One of these, mentioned in the description, are the short, thick hairs on the involucres. These hairs, which are crystal-clear, curved, and blunt, have never been observed elsewhere in the genus. The other character is found in the cells of the perianth lobes. These cells form a roughened surface which appears minutely scaly.

**25. Chorizanthe fimbriata** Nutt. Jour. Acad. Phila. N. S. **1**: 168. 1848; Benth. in DC. Prodr. **14**: 25. 1857; Torrey, Pacif. R. R. Rept. [Desc. of plants collected by W. P. Blake at mouth of Gila] **5**: 364, *pl. 8.* 1857; Torr. & Gray, Proc. Am. Acad. **8**: 195. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 271. 1877; Wats. Botany [of California] **2**: 36. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 58. 1884; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{1a}$: 11. 1891; Greene, Fl. Francis. 157. 1891; Hall, Univ. Calif. Publ. Bot. [Bot. Surv. San Jacinto Mountain] **1**: 72. 1902; Jepson, Fl. Calif. 394. 1914; Armstrong, Field Book West. Flowers, 86. *fig.* on p. 87. 1915; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 298. 1923, excluding variety.

Erect plants, 1.5–3 or even 5 dm. tall; stem 1 to few from the base, trichotomously branched at the first node, branches spreading, pubescent; leaves petiolate, obovate-spathulate, truncate to emarginate, tapered below the blade to petiolar wings, 3–5 cm. long, in mature specimens villous-hirsute beneath, pubescent above; bracts rarely foliaceous, acerose and spreading; inflorescence broadly cymose, the involucres in small, rather dense clusters at the ends of the branches; involucres 5–6 mm. long, the tube cylindric, about 4.5 mm. long, pubescent, sometimes densely so, teeth widely spreading, inner considerably shorter than the outer, all recurved or uncinate; flower conspicuously exserted, 5.5–7 mm. long, tube cylindric, segments ascending, about as long as the tube, all similar, the inner a little shorter, the margins fimbriate except for the linear and entire terminal lobe; stamens 9, anthers short-elliptic; styles 4 mm. long.

Type: "St. Diego, Upper California," 1836, *Nuttall* (Ph).

Distribution: western Riverside County and Los Angeles County, California, southward through the western half of San Diego County to Lower California.

Specimens examined:

CALIFORNIA: RIVERSIDE COUNTY—Dripping Springs, Temecula, alt. 1500 ft., June 22, 1920, *Peirson 2165* (Pe); dry hills, near Murietta, May 18, 1922, *Munz & Johnston 5318* (Pom); near Murietta, May 19, 1922, *Peirson 3024* (Pe); LOS ANGELES COUNTY—Pasadena, May, 1882, *Jones* (D, Pom); SAN DIEGO COUNTY—"St. Diego," 1836, *Nuttall* (G fragment, M photograph, Ph TYPE); San Diego, May, 1852, *Thurber 618* (G); San Diego, 1860–1861, *Cooper* (G); San Diego, 1868–69, *Kellogg & Harford* (US); San Diego, 1875, *Cleveland* (M); San Diego, June, 1875, *Palmer 353* (M); San Diego, 1876, *Cleveland* (Par); San Diego, 1880, *Cleveland* (M); Fallbrook, March 28, 1882, *Jones* (Pom); Soledad, March 28, 1882, *Jones* (Pom); San Diego, April 19, 1882, *Jones* (Pom); San Diego, May, 1882, *Parry* (M, US); hills, San Diego, April 29, 1882, *Pringle* (Ph, US); San Diego Falls, June 25, 1883, *Orcutt* (G); Potrero, June, 1889, *Orcutt* (US); San Diego, June, 1891, *Blaisdell 87* (CAS); Jamul Valley, July 2, 1894, *Schoenfeldt 3828* (US); Del Mar, March 22, 1895, *Angier 184* (M); Ocean Beach, May 16, 1897, *Minnie Reed* (Pom); near Pala, May 31, 1897, *Parish 4399* (G, M, US); June, 1897, *Redman* (G); San Diego, May 25, 1902, *Brandegee 1631* (CAS, G, M, Pom, RMt, US); San Diego, July 1, 1902, *Herre* (Pom); Mission Hills, San Diego, May 8, 1903, *Abrams 3426* (M, Ph, Pom, US); San Diego, April, 1905, *Brandegee* (US); San Diego, 1906, *K. Brandegee* (M, Pom, RMt, US); Point Loma, April 21, 1913, *Eastwood 2881* (CAS); Point Loma, April 21, 1913, *Eastwood 2886* (CAS); Tia Juana, April 24, 1913, *Eastwood 2916* (CAS); La Jolla, April 25, 1914, *Clements & Clements 52* (G, M, Ph); La Jolla, May 16, 1914, *Clements & Clements 50* (G, Ph); La Jolla, June 3, 1914, *Clements & Clements 51* (G, M, Ph); Point Loma, June 6, 1915, *Collins & Kempton 167* (US); Otay Mesa, near San Diego, July 16, 1915, *Collins & Kempton 2* (US); near San Diego, May 12, 1916, *Spencer 32* (US); near Fallbrook, alt. 750 ft., May 15, 1920, *Munz & Harwood 3852* (Pom, RMt, US); north of Pala, alt. 750 ft., June 21, 1924, *Peirson 4763* (Pe); near Bonsal, June 13, 1928, *Wiggins 3043* (D); near Rincon, Palomar Mts., June 14, 1928, *Wiggins 3108* (D); San Onofre Canyon, alt. 550 ft., May 16, 1929, *C. L. Hitchcock* (Pom); near San Diego, June 4, 1931, *Howell 6634* (CAS, M); near Dulzura, May 15, 1932, *Munz & Johnston 12618* (E, M).

Lower California: April 13, 1883, *Orcutt* (US); San Telmo, April 16, 1886, *Orcutt* (US); Vallecito, May 22, 1886, *Orcutt* (M); near Tecate, alt. 600 m., May 30, 1932, *Fosberg 8279* (E).

Considerable variation occurs in the height of these plants and in the shape and size of the leaves. The fimbriate perianths mark this and the next species conspicuously, however.

The specimen of Orcutt (hb. Gray) from San Diego Falls, has very large leaves, and is atypical. Another specimen of Orcutt (hb. U. S. National) from Potrero is in the range of *C. laciniata*. Specimens bearing this same data (hb. Missouri Botanical Garden) are referable to the latter species.

26. **Chorizanthe laciniata** Torr. Pacif. R. R. Rept. 7: 19. 1856; Torr. & Gray, Proc. Am. Acad. 8: 194. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] 5: 484. 1871; Wats. Proc. Am. Acad. 12: 271. 1877; Wats. Botany [of California] 2: 37. 1880; Parry, Proc. Davenp. Acad. Sci. 4: 58. 1884.

*Chorizanthe fimbriata* Nutt. var. *laciniata* (Torr.) Jepson, Fl. Calif. 394. 1914; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 298. 1923.

Erect plants, 1–2 dm. tall; stem 1 to few from the base, spreading, branched above, pubescent; leaves petiolate, partly winged, broadly spathulate, emarginate, about 2 cm. long, lanate to sparsely pubescent; involucres 4 mm. long, tube subcylindric, about the same length, usually canescent, teeth very widely spreading, spines down-curved to uncinate, the inner 3 considerably shorter; flower conspicuously exserted, 7–9 mm. long, tube cylindric, perianth segments finely fimbriate, the terminal lobe very narrow; stamens 9, anthers short-elliptic; styles long.

Type: San Felipe, Imperial County, California, May, 1855, *Antisell.*

Distribution: western Riverside County, California, southward but inland to Lower California.

Specimens examined:

California: Riverside County—Coahuila, San Jacinto Mts., June, 1882, *Parish Bros. 333* (Par); Aguanga, June, 1882, *Parish Bros. 1612* (M); Coahuila, San Jacinto Mts., June, 1882, *Parish Bros. 1612* (D); Aguanga, June, 1883, *Parish Bros. 1617* (US); San Diego County—San Diego, 1870, *Palmer* (Par); San Diego, 1876, *Palmer* (Par); Smith's Mt., June, 1880, *Vasey 535* (Par, US); Larkin's Station, 1880, *Vasey 543* (US); June, 1880, *Vasey 545* (Par); Potrero, July 24, 1883, *Orcutt 919* (Par); 1889, *Orcutt* (US); Potrero, June, 1889, *Orcutt* (M); Mountain Spring, May 10, 1894, *Mearns 3032* (US); Mountain Springs, May 12, 1894, *Schoenfeldt 3087* (US); summit of wagon pass, Coast Range, May 15, 1894, *Mearns 3199* (US); Jacumba Hot Springs, May 20, 1894, *Mearns 3243* (US); Jacumba Hot Springs, May 31, 1894, *Schoenfeldt 3359* (US); Cameron's Ranch, Laguna, June 22, 1894, *Schoenfeldt 3710* (US); Potrero, July, 1895, *Stokes* (D); Stonewall mine, Cuyamaca Mts., alt. 4600 ft., June 5–7, 1897, *Parish* (D); Oak Grove, July 13, 1900, *Jones* (Pom); dry sand hills, Jacumba, May 31, 1903, *Abrams 3661* (D, M, Pom); Viejas, June 16, 1906, *K. Brandegee* (D, US); Descanso, June, 1910, *K. Brandegee* (US); Warner's Springs, 1911, *Coombs* (CAS); Hot Spring Mountain, Warner's Hot Springs, 1913, *Buttle* (CAS); San Ysabel, July 29, 1915, *Collins & Kempton 253* (US); Julian, July 29-30, 1915, *A. S. Hitchcock* (US); Viejas, June 16, 1916, *K. Brandegee* (Pom); Live Oak Springs, Laguna Mts., August 6, 1916, *McGregor 62* (D); Jacumba, June 10, 1917, *McGregor 1015* (D); Cuyamaca, June 25, 1919, *Eastwood 9162* (CAS); between Jacumba and Mountain Springs, April 24, 1920, *Eastwood* (CAS); Alpine, June 27, 1923, *Munz & Harwood 7145* (Pom, RMt); dry slope, Jacumba, May 10, 1924, *Munz 8060* (Pom); Vallecito Cañon, Laguna Mts., June 26, 1924, *Peirson 4881* (Pe); sandy wash, near Jacumba, alt. 4000 ft., May 15, 1925, *Munz 9624* (Pom); San Felipe Valley, alt. 3000 ft., May 17, 1925, *Keck & McCully 67* (Pom); Henshaw Dam, alt. 3800 ft., May 26, 1926, *Jaeger* (Pom); between Jacumba and Mountain Springs, April 18, 1928, *Ferris 7049* (D); San Felipe Creek, near Sentenac Canyon, April 20, 1928, *Peirson 7847* (Pe); between El Centro and Jacumba, June 10, 1928, *Johnson* (CAS); San Felipe Ranch, alt. 2500 ft., May 6, 1929, *Munz & Hitchcock 11366* (Pom); near Warner Hot Springs, alt. 950 m., June 5, 1932, *Fosberg 8277* (E); Imperial County—San Felipe, 1855, *Antisell* (Par isotype fragment); San Felipe, April, 1899, *K. Brandegee* (D); San Felipe Hill, alt. 2400 ft., April 19, 1906, *Jones* (Pom).

Lower California: near U. S. Boundary Mts., July 12, 1884, *Orcutt 919* (M, US).

Not only does *C. laciniata* have a geographic distribution which lies immediately to the east of the range of *C. fimbriata*, but also it is separable from the latter on several morphologic characters. The smaller leaves, the smaller average size of the plants, and more canescent involucres nearly always accompany *C. laciniata*, and the finely laciniate perianth segments, with the very narrow terminal lobes, form the best character.

Subsection 3. UNIARISTATAE, new subsection. Erect or decumbent plants. At least the lower bracts foliaceous. Involucres with the anterior tooth longer than the others. Perianth subcylindric; outer lobes entire, subentire, or rarely bilobed; inner lobes usually shorter, variously fimbriate, or only erose. Stamens attached at base of perianth tube. Species 27–32, incl.

Range: Mendocino County to Ventura County, California, chiefly in Monterey, and San Luis Obispo Counties.

In the species of this subsection where the inner perianth lobes are but erose, the long tooth of the involucre is conspicuously elongated.

**27. Chorizanthe obovata** Goodman, n. sp.[39]

Erect plants, 1–3 dm. tall; stem one, or few from the base, usually trichotomously branched below and dichotomously above, subappressed or spreading pubescent; leaves basal or nearly so, oblanceolate, long-petiolate, blade 1–2 cm. long, densely but rather softly hirsute beneath, sparsely so above; lower bracts foliar, strigose, mucronate to awn-pointed, upper bracts subulate; inflorescence glomerate or disposed in closely aggregated flat-topped cymes; involucres urceolate, 4.5–5 mm. (or rarely more) long, grayish with an ascending pubescence or rarely but slightly hairy, tube 3–4 mm. long, teeth divergent, the 3 inner and 2 of the slightly longer outer ones uncinate, the anterior one noticeably longer (2 mm.) and straight or downcurved; flowers nearly sessile, slightly exserted, 4–4.5 mm. long, glabrous, tube slightly longer than the outer lobes, outer lobes obovate, narrowed at the base, truncate, inner lobes two-thirds as long as the tube, shortly oblong, finely fimbriate at sides and top; stamens 9, anthers linear and over 1 mm. long.

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[39] **Chorizanthe obovata** Goodman, sp. nov. Planta erecta, 1–3 dm. alta; caulibus solitariis aut paucis e base, subappressis vel diffuse pubescentibus, plerumque infra trichotome ramosis et supra dichotome ramosis; foliis basalibus vel subbasalibus, oblanceolatis, longe-petiolatis, laminis 1–2 cm. longis, subter dense et molliuscule hirsutis, supra sparse hirsutis; bracteis inferioribus foliaceis, strigosis, mucronatis vel aristatis, bracteis superioribus subulatis; inflorescentia conferta aut in cymis planis aggregatis; involucris urceolatis, 4.5–5 (raro plus) mm. longis, cinereo-adscendente-pubescentibus aut raro hirsutulis, tubo 3–4 mm. longo, dentibus divergentibus, 5 uncinatis, dente anteriore conspicue longiore (2 mm.) et recto aut recurvato; floribus subsessilibus, paulo exsertis, 4–4.5 mm. longis, glabris, lobis exterioribus tubo parum brevioribus, obovatis, ad basem attenuatis, truncatis, lobis interioribus longitudini ⅔ tubi adaequantibus, breve oblongis, ad latera et summum minute fimbriatis; staminibus 9, antheris linearibus, plus 1 mm. longis.—Price Cañon, near the coast of San Luis Obispo County, California, 1911, *K. Brandegee 84* (M TYPE).

Type: Price Cañon, near the coast of San Luis Obispo County, California, 1911, *K. Brandegee 84* (M).

Distribution: San Benito and Monterey Counties, southward into Santa Barbara County, California.

Specimens examined:

CALIFORNIA: SAN BENITO COUNTY—Hernandez, June 7, 1903, *Lathrop* (D); MONTEREY COUNTY—Priest Valley, alt. 2373 ft., August 15, 1929, *Rowntree* (E); SAN LUIS OBISPO COUNTY—San Luis Obispo, July, 1885, *Brandegee* (CAS); Santa Margarita, June, 1889, *Parry* (Par); Price Cañon, near the coast, 1911, *K. Brandegee 84* (D, G, M TYPE, Pom, RMt, US); on road between Arroya Grande and Huasna, July 30, 1927, *Eastwood 14981* (CAS); on new road to Pozo, May 17, 1928, *Eastwood* (CAS); along Chorro Creek, among rocks, May 17, 1928, *Eastwood 15121* (CAS); on old road to Pozo, May 17, 1928, *Eastwood 15137* (CAS); SANTA BARBARA COUNTY—near Mono Flat Ranger Station, alt. 1500 ft., July 3, 1923, *A. L. Grant 1685* (M); sandy field, 7 miles west of Buellton, May 30, 1929, *Hoffmann* (E); rocky slope above ocean, 3 miles south of Point Sal, May 31, 1931, *Hoffmann 371* (CAS).

Representatives of this species have for the most part been referred heretofore to *C. Palmeri*. The shapes of the perianth lobes differentiate the species with certainty.

**27a. Chorizanthe obovata** Goodman forma **prostrata** Goodman, n. form.[40]

Plants prostrate; long tooth of the involucre straight or uncinate. Otherwise like the species.

Type: hills near San Luis Obispo, California, June, 1878, *Lemmon* (M).

Distribution: San Luis Obispo and Santa Barbara Counties, California.

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[40] **Chorizanthe obovata** Goodman forma **prostrata** Goodman, forma nov. Planta prostrata, involucri longo dente recto vel uncinato. Cetera speciei similis.—Hills near San Luis Obispo, California, June, 1878, *Lemmon* (M TYPE).

Specimens examined:

CALIFORNIA: SAN LUIS OBISPO COUNTY—hills near San Luis Obispo, June, 1878, *Lemmon* (M TYPE, Ph); SANTA BARBARA COUNTY—San Marcos Pass, August 16, 1927, *Hoffmann* (Pom).

**28. Chorizanthe rectispina** Goodman, n. sp.[41]

*Chorizanthe uniaristata* of auths., in part.

Spreading to decumbent plants; stems several from the base, 1–2 dm. long, gray with an appressed pubescence; leaves basal, oblanceolate or spathulate, 1.5–3 cm. long, obtuse, villous-hirsute; bracts foliaceous, similar to the leaves in outline, 0.5–1 cm. long, tipped with a conspicuous awn; inflorescence of compound uniparous cymes; involucres, urceolate-cylindric, gray-pubescent, 6-ribbed, the tube 2–2.5 mm. long, 5 of the teeth short and uncinate, widely spreading, the anterior one as long as or much longer than the tube, straight and divergent; flowers partly exserted, about 3.5 mm. long, appressed-pubescent on the outer surface along the six veins, the segments very unequal, the outer 3 nearly as long as the perianth tube, broadly obovate to suborbicular and truncate, subentire, the inner 3 half as long, oblong, erose to finely fimbriate, mostly obtuse; stamens 9, anthers linear-oblong, a little over 0.5 mm. long; achene 2.5 mm. long.

Type: McGinness, 25 miles northeast of San Luis Obispo, California, July 10, 1876, *Palmer 466* (M).

Distribution: San Luis Obispo and Santa Barbara Counties, California.

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[41] **Chorizanthe rectispina** Goodman, sp. nov. Planta diffusa vel decumbens; caulibus pluribus e base, 1–2 dm. longis, cinereo-appresso-pubescentibus; foliis basalibus oblanceolatis vel spathulatis, 1.5–3 cm. longis, obtusis, villoso-hirsutis; bracteis foliaceis, circumscriptione foliis similibus, 0.5–1 cm. longis, ad apicem conspicue aristatis; inflorescentia in cymis compositis uniparitis; involucris urceolato-cylindricis, cinereo-pubescentibus, 6-costatis, tubo 2–2.5 mm. longo, 5 dentibus brevibus uncinatisque, late divergentibus, anteriore dente tubi longitudinem adaequante vel superante, recto et divergente; floribus paulo exsertis, circiter 3.5 mm. longis, exteriore appresso-pubescentibus, laciniis inaequalissimis, exterioribus 3 tubo perigonii subadaequantibus, late obovatis vel suborbiculatis et truncatis, subintegris, bis longioribus quam 3 interioribus, interioribus oblongis, erosis vel fimbriatis, plerumque obtusis; staminibus 9, antheris lineari-oblongis, plus 0.5 mm. longis; achaenio 2.5 mm. longo.—McGinness, 25 miles northeast of San Luis Obispo, California, July 10, 1876, *Palmer 466* (M TYPE).

Specimens examined:

CALIFORNIA: SAN LUIS OBISPO COUNTY—McGinness, 25 miles northeast of San Luis Obispo, July 10, 1876, *Palmer 466* (CAS, M TYPE, Par, Ph, US); SANTA BARBARA COUNTY—Blochman's Ranch, June 15, 1906, *Eastwood 452* (CAS); sandy flat, San Marcos Pass, Santa Ynez Mts., May 31, 1929, *Hoffmann* (E).

The inflorescences in this species superficially resemble cylindric racemes. This appearance is attained through the relatively slight elongation (commonly less than 5 mm.) of the longer branches of the uniparous cymes.

The long, straight tooth of the involucre caused this species to be confused with *C. uniaristata,* the error having been initiated by Dr. Watson. However, the new species is abundantly distinct. The partially exserted perianths of *C. rectispina* enable one to distinguish it from *C. uniaristata,* even with the unaided eye. With a hand lens the broadly obovate outer lobes of the perianth are readily seen.

The presence of 3 stamens in *C. uniaristata* seems to be a constant character for that species, whereas 9 stamens, with large anthers, have always been found in *C. rectispina.* The nearest relative of *C. rectispina* is *C. obovata.*

**29. Chorizanthe biloba** Goodman, n. sp.[42]

*Chorizanthe Palmeri* Wats. acc. to Parry, Proc. Davenp. Acad. Sci. 4: 57. 1884, at least as to part of description and specimens from Monterey County.

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[42] **Chorizanthe biloba** Goodman, sp. nov. Planta erecta, 1.5–3.5 dm. alta; caulibus solitariis vel paucibus e base, supra dichotome aut trichotome ramosis, saepe verticillium medium bractearum foliacearum ferentibus, appresse crispo-pubescentibus et plerumque ad inflorescentiam pilis longis et divergentibus; foliis basalibus ellipticis et sessilibus vel oblanceolatis et petiolatis, 1–5 cm. longis, appresse-pubescentibus, supra minus dense pubescentibus; bracteis inferioribus foliaceis, foliis similibus sed aristatis, bracteis superioribus minoribus, 8 mm. longis, in aristam longam rectam terminatis; inflorescentia in glomerulis crebris cymosis; involucris subcylindricis, 5–7 mm. longis, cinereo-pubescentibus et ad costas grosse hirsutis, tubo 4–4.5 mm. longo, dentibus brevibus, diffusis, uncinatis, dente anteriore longiore quam ceteris; floribus parte exsertis, 5–6 mm. longis, glabris aut sparse pubescentibus, lobis 2 mm. longis, exterioribus obovatis ad basem attenuatis, obcordatis vel bilobatis, interioribus oblongis, obtusis, superiore ⅓ parte fimbriato; staminibus 9, antheris lineari-oblongis, 2 mm. longis.—Paso Robles, San Luis Obispo County, California, in the coast ranges, 1911, *K. Brandegee* (M TYPE).

Erect plants, 1.5–3.5 dm. tall; stem one or few from the base, dichotomously or trichotomously branched above, frequently bearing a medial whorl of foliar bracts, appressed curly-pubescent and commonly with some long spreading hairs intermixed toward the inflorescence; leaves basal, elliptic and sessile to oblanceolate and petiolate, 1–5 cm. long, appressed-pubescent, less densely so above; bracts at the lower branches foliaceous, similar to the leaves but awn-pointed, upper bracts much reduced, 8 mm. long, tipped with a long, straight awn; inflorescence of close cymose clusters, involucres subcylindric, 5–7 mm. long, gray-pubescent and with coarser, spreading hairs on the ribs, tube 4–4.5 mm. long, teeth short, spreading, uncinate, anterior tooth longer than the others; flowers partly exserted, 5–6 mm. long, glabrous or slightly pubescent on the outer surface on the midveins, lobes 2 mm. long, outer obovate, narrowed at base, obcordate to bilobed, inner oblong, obtuse, upper third fimbriate; stamens 9, anthers linear-oblong, 2 mm. long.

Type: Paso Robles, San Luis Obispo County, California, in the coast ranges, 1911, *K. Brandegee* (M).

Distribution: San Benito and Monterey Counties, southward into Santa Barbara County, California.

Specimens examined:

CALIFORNIA: SAN BENITO COUNTY—near Hernandez, August 17, 1933, *Howell 11551* (CAS); MONTEREY COUNTY—*Abbott* (CAS); Jolon, July, 1880, *Vasey 534* (US); Reliz Cañon, near Santa Lucia Peak, July, 1891, *Norton* (D); Jolon, July 19, 1910, *K. Brandegee* (D, US); Jolon, July 5, 1929, *Rowntree* (Pom); SAN LUIS OBISPO COUNTY—Paso Robles, *Parry* (Par); in the coast ranges, Paso Robles, 1911, *K. Brandegee* (D, M TYPE, Pom, RMt, US); Paso Robles, June 18, 1914, *C. P. Smith 2849* (CAS, D); Paso Robles, May 4, 1926, *Eastwood 13812* (CAS); flats near Paso Robles, June, 1927, *C. Dudley* (CAS); Creston, alt. 1000 ft., June 29, 1927, *Feudge 1644* (Pom); SANTA BARBARA COUNTY—Santa Inez Mts., May 21, 1891, *Dunn* (US); gravelly slope, Figueroa Mt., San Rafael Range, May 30, 1929, *Hoffmann* (E).

For many years Pacific Coast botanists have realized, as indicated by notes and question marks on herbarium sheets, that the members of this species could not satisfactorily be referred to any known species. Parry,[43] under *C. Palmeri*, describes this species in large part, and certainly as to the perianth. Mate-

[43] Parry, Proc. Davenp. Acad. Sci. 4: 57. 1884.

rial of *C. biloba*, as well as of *C. obovata*, have heretofore been referred chiefly to *C. Palmeri*.

30. **Chorizanthe Palmeri** Wats. Proc. Am. Acad. **12**: 271. 1877; Wats. Botany [of California] **2**: 36. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 57. 1884, in part; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{1a}$: 11. 1891; Greene, Fl. Francis. 155. 1891; Jepson, Fl. Calif. 394. 1914, in part; Jepson, Man. Fl. Pl. Calif. 298. 1923, in part.

Erect plants, 1–2 dm. tall, the appressed-pubescent stems solitary, branching near or above the middle; leaves arranged along the lower portion of the stem, spathulate to oblanceolate, on slender petioles, blades 2–3 cm. long, weakly strigose below, more sparsely so above; cauline bracts verticillate and foliar, oblanceolate, bracts subtending the inflorescence smaller and awn-tipped, or subulate; inflorescence of dense cymose clusters; involucres subcylindric, about 4.5 mm. over all, tube commonly slightly gibbose at base of rib leading to the large anterior tooth, 3–4 mm. long, grayish-pubescent, teeth slightly divergent and uncinate, very short except the anterior one, this noticeably longer and sometimes scarcely uncinate; flower 3.5–5 mm. long, glabrous, outer lobes nearly 1 mm. long, orbicular, inner lobes a little shorter, shortly obovate, retuse to emarginate and finely fimbriate across the top; stamens 9, anthers versatile, oblong-linear, remarkably long (1.5 mm).

Type: San Luis Obispo, California, June 26, 1876, *Palmer 464* (G).

Distribution: San Luis Obispo County, California.

Specimens examined:

CALIFORNIA: SAN LUIS OBISPO COUNTY—San Luis Obispo, June 26, 1876, *Palmer 464* (M, Par, Ph, isotypes); San Luis Mt., May–July, *Summers* (M, Pom, RMt, US); Five Mile House, near San Luis Obispo, *K. Brandegee* (D, Pom); stony, dry, open hills, June, 1884, *Summers* (US); San Luis Obispo, 1885, *Summers* (US); from Atascadero to Beach, July 24, 1920, *Abrams 7655* (D); Polytechnic School grounds, San Luis Obispo, July 21, 1925, *McDonald* (CAS); Walter's Ranch, San Luis Obispo, August 31, 1925, *Sampson* (D); on serpentine near San Luis Obispo, July 31, 1927, *Eastwood 15015* (CAS).

A confusion has occurred in regard to Vasey's *534a* in the United States National Herbarium. The label reads, "Jolon, Monterey Co., California, 1880. Outer lobes of corolla deeply bifid." The specimen originally referred to was doubtlessly *C. biloba,* which species includes Jolon in its range. The specimen on the sheet, however, is typical *Palmeri.*

31. **Chorizanthe Clevelandii** Parry, Proc. Davenp. Acad. Sci. 4: 62. 1884; Greene, Fl. Francis. 156. 1891; Greene, Man. Bot. Reg. San Francis. Bay, 49. 1894; Jepson, Fl. West. Mid. Calif. 151. 1901, and ed. 2. 130. 1911; Jepson, Fl. Calif. 395. 1914; Jepson, Man. Fl. Pl. Calif. 298. 1923.

More or less decumbent plants; stems several from the base, spreading pubescent; leaves basal, petioled, oblanceolate, 1–3 cm. long, obtuse, gray-pubescent; foliaceous bracts lanceolate to oblanceolate, conspicuously awned; bracts subtending the involucres acerose; inflorescence of compound uniparous cymes, the small clusters of involucres occurring at short intervals; involucres covered with spreading pubescence, the tube urceolate, triangular in cross-section, 3–3.5 mm. long, all of the 6 teeth uncinate, the anterior one considerably longer than any of the others and frequently exceeding the length of the tube; flower on a very short pedicel, included, 3.5 mm. long, the upper portion of the veins very sparingly appressed-pubescent, the outer perianth lobes a little less than 1 mm. long, ovate, minutely erose, commonly emarginate, inner lobes a little less than half as long, broadly ovate, conspicuously erose; stamens 3, opposite the inner lobes, anthers elliptic.

Type: Allen Springs, Lake Co., California, June, 1882, *Cleveland* (Par).

Distribution: an intermittent distribution as judged from present collections, and known from the following counties in California: Mendocino, Lake, San Benito, Monterey, Tulare, and Ventura.

Specimens examined:

CALIFORNIA: MENDOCINO COUNTY—Ukiah, August, 1882, *Pringle* (Par); LAKE COUNTY—Allen Springs, June, 1882, *Cleveland* (M, Par TYPE); June, 1886, *K. Brandegee* (Ph, Pom); Allen Springs, June, 1888, *Simonds* (M); Rice Fork of Eel River, July 5, 1928, *M. S. Baker 3097b* (CAS); Bogg's Lake, Mt. Hannah, alt. 3000 ft., July 14, 1929, *Blankinship* (M); near Mirabel Mine, July 9, 1931, *M. S. Baker 5360* (CAS); between Cobb Mt. and Adams Spring, June 25, 1933, *Jussel 143* (CAS); Coleman Place, Cobb Mt., June 27, 1933, *Jussel 276* (CAS); SAN BENITO COUNTY—near Dominicks, San Benito River, June 3, 1899, *Dudley*

(D); near Hernandez, August 17, 1933, *Howell 11552* (CAS); MONTEREY COUNTY —Tassajara Hot Springs, June, 1901, *Elmer 3245* (D, M, Pom, US); TULARE COUNTY—vicinity of Second Dry Meadow Creek, Kern River, July 15, 1895, *Dudley 733* (D); VENTURA COUNTY—below Mission Pines, San Rafael Mts., alt. 4500 ft., July 26, 1930, *Hoffmann* (CAS, Pom).

32. **Chorizanthe uniaristata** Torr. & Gray, Proc. Am. Acad. 8: 195. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] 5: 484. 1871; Wats. Proc. Am. Acad. **12**: 272. 1877, in part; Wats. Botany [of California] **2**: 38. 1880, in part; Parry, Proc. Davenp. Acad. Sci. **4**: 61. 1884, in part; Greene, Fl. Francis. 156. 1891, in small part; Jepson, Fl. West. Mid. Calif. 151. 1901, in part, and ed. 2. 130. 1911, in part; Jepson, Fl. Calif. 395. 1914, in part; Jepson, Man. Fl. Pl. Calif. 298. 1923, in part.

Decumbent plants; stems usually several from the base, 1 dm. or more long, spreading pubescent; leaves basal and petiolate, oblanceolate, 2–3 cm. long, long-pubescent; bracts narrowly linear and acerose; inflorescence of uniparous cymes, or sometimes of nearly equally branched cymes, the involucres occurring in small clusters; involucres cylindric, urceolate, pubescent with ascending hairs, tube 2–2.75 mm. long, 5 of the teeth widely spreading, recurved or uncinate, the anterior one divergent, straight, and equalling or twice the length of the tube; flower slender, included or but inconspicuously exserted, about 2.75 mm. long, sparsely pubescent on the veins, outer lobes linear-oblong to linear-oblanceolate, rounded and minutely erose at apex, 1 mm. long, inner scarcely half so long, and half as wide, linear, obtuse, slightly erose; stamens 3, opposite the inner lobes, anthers suborbicular.

Type: dry places, New Idria, California, *Brewer* (G).

Distribution: San Benito, Fresno, Monterey, and Kern Counties, California.

Specimens examined:

CALIFORNIA: SAN BENITO COUNTY—mountains near New Idria, July, 1861, *Brewer 2739* (US part of TYPE collection); FRESNO COUNTY—dry, sandy loam, near Kingsburg, June 27, 1901, *Kearney 72* (M, US); MONTEREY COUNTY—near Mt. Diablo, 1884, *Curran* (D); Palisades, June, 1891, *Norton* (CAS); near Gonzales, July, 1891, *Norton* (CAS, D); foot of Jolon grade, June 7, 1909, *K. Brandegee* (US); Jolon, June 8, 1909, *K. Brandegee* (D); on stony hilltops, Jolon, June, 1915, *Hall 10033* (US); KERN COUNTY—Walker Basin, alt. 1000 m., June 24, 1901, *Coville & Funston 1090* (D, US); plains east of Bakersfield on Tehachapi Road, June 12, 1921, *Ferris & Duncan 2205* (CAS, D); between Caliente and Bodfish, near Walker Basin, July 9, 1933, *Peirson 10684* (M, Pe).

That *C. Clevelandii* and *C. uniaristata* are closely related there can be no doubt, although there are several morphological differences between them as delineated in the descriptions. The two species can be readily separated by the character of the long tooth of the involucre. In *C. Clevelandii* this spine is uncinate, in *C. uniaristata,* straight.

Subsection 4. PARRYANAE, new subsection. Spreading, gray-pubescent plants with basal leaves and foliaceous bracts. Involucral tubes short (about 2 mm. long), the teeth widely spreading. Perianth partially exserted, slightly pubescent, outer surface white; tube cylindric; outer lobes longer than the inner. Stamens 9, inserted at the base of the perianth. Species 33–34.

Range: Los Angeles and western Riverside Counties south into northern Lower California.

**33. Chorizanthe Parryi** Wats. Proc. Am. Acad. **12**: 271. 1877; Wats. Botany [of California] **2**: 37. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 61. 1884; Dammer in Engl. & Prantl, Nat. Pflanzenfam. **3$^{1a}$**: 12, *fig. 5 N.* 1891; Abrams, Fl. Los Angeles & Vicinity, 114. 1904, and ed. 2. 105. 1917; Jepson, Fl. Calif. 395. 1914, excluding synonymy; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 298. 1923.

Diffuse or decumbent plants, a few cm. to as much as 3 dm. high; stems several from the base, ascending pubescent to canescent; leaves oblanceolate, frequently narrowly so, and tapered to a petiole, commonly mucronate, 2–7 cm. long, scantily pubescent to canescent beneath, glabrate to sparsely pubescent above; lower bracts similar to the leaves, the upper ones acerose; inflorescence chiefly a loose cyme, the involucres aggregated at the ends of the branches into small clusters; involucres 6-ribbed, urceolate, about 3 mm. long, appressed-pubescent, tube triangular in cross-section, 2 mm. long, the larger teeth squarrose, as long as the tube, shortly recurved or uncinate, inner teeth very short, uncinate; flower 2.5–3.25 mm. long, segments widely spreading, outer oblong-obovate to oblong, obtuse, commonly erose, about 1.25 mm. long, inner linear-lanceolate, subacute, entire, 0.5 mm. shorter; anthers oblong, achene 2.25 mm. long.

Type: gravelly mesas near Crofton, San Bernardino County, California, coll. of 1876, *Parry* (G).

Distribution: western San Bernardino and Riverside Counties, Los Angeles County and southward into San Diego County, California.

Specimens examined:

CALIFORNIA: SAN BERNARDINO COUNTY—1876, *Parry & Lemmon 370* (M, Par); San Bernardino, 1880, *Parish* (M); San Bernardino, May, 1880, *Vasey 540* (US); San Bernardino, 1881, *Parry 269* (M, Par, US); San Bernardino, May, 1881, *Parish Bros. 827* (D, ISC, Ph, US); Colton, April 27, 1882, *Jones 3181* (CAS, D, M, Pom, US); sandy plains, Colton, May 29, 1882, *Pringle* (Ph, US); sandy plains, May, 1888, *Parish* (M); Rialto, May 29, 1889, *Parish* (M); Arrowhead Springs, May 11, 1891, *Fritchey 44* (M); Yucaipe, San Bernardino Mts., alt. 2500 ft., June 13, 1894, *Parish 3218* (US); vicinity of San Bernardino, April 10, 1900, *Parish* (D); Yucaipe, alt. 2500 ft., May, 1900, *Parish* (Pom); vicinity of San Bernardino, April 27, 1901, *Parish 4703* (D); Redlands, May, 1906, *Greata 455* (CAS); Arrowhead Hot Springs, May 22, 1906, *Grant* (Pom); Arrowhead Hot Springs, May 22, 1906, *Grant 6627* (D); Arrowhead Hot Springs, alt. 1750 ft., May 21–28, 1906, *Grant 6642* (D); East Highlands, April 16, 1915, *Cox* (Pom); dry mesas, San Bernardino Valley, alt. 300 m., May 17, 1917, *Parish 11219* (Pom); sandy wash, Lytle Creek, San Bernardino Valley, July 8, 1917, *Johnston* (Pom); sandy wash, Highland, alt. 1000 ft., May 7, 1919, *Spencer 1183* (CAS, Pom); Arrowhead Hot Springs, alt. 1000 ft., May 9, 1919, *Spencer 1103* (CAS, Pom); between Claremont and Upland, June 2, 1921, *Robinson 71* (Pom, RMt); near Arrowhead Hot Springs, alt. 1350 ft., April 28, 1923, *Feudge 240* (Pom); sandy soil, east of Upland, alt. about 1000 ft., June 11, 1927, *Howell 2482* (CAS); RIVERSIDE COUNTY—San Gorgonio, *Parry* (M, Par); Elsinore, May, 1901, *Mrs. J. D. Abrams* (D); Banning, alt. 2300 ft., May 11, 1903, *Jones* (CAS, D, Pom); Palm Springs, March 25, 1920, *Jaeger 1058* (Pom); near Murietta, alt. 1500 ft., May 19, 1922, *Munz & Johnston 5359* (Pom); near Murietta, May 19, 1922, *Peirson 3055* (Pe); San Gorgonio Pass at Cabazon, June 5, 1931, *Howell 6658* (CAS, M); LOS ANGELES COUNTY—Claremont, June 10, 1900, *Shaw* (Pom); Glendora, May 14, 1902, *Grant* (D); Mt. Lowe, alt. 4000 ft., June, 1902, *Grant 171* (D); Claremont, April, 1912, *Howery* (M); Claremont, June 15, 1912, *de Camp* (M); dry wash in chaparral, Claremont, May 13, 1919, *Munz 2790a* (Pom); San Gabriel Wash, San Gabriel Mts., alt. 600 ft., May 12, 1920, *Peirson 2131* (Pe); mountains near Claremont, May 21, 1926, *Jones* (D, Pom); Claremont, June 15, 1928, *Eastwood 15383* (CAS); San Gabriel Wash, alt. 350 ft., May 26, 1932, *Wheeler 744* (M); Thompson Creek Dam near Claremont, alt. 1600 ft., May 27, 1932, *Wheeler 765* (M); SAN DIEGO COUNTY—Soledad, March 28, 1882, *Jones* (Pom); COUNTY NOT KNOWN—alt. 500 m., April 13, 1898, *Leiberg 3300* (US).

**33a. Chorizanthe Parryi** Wats. var. **fernandina** (Wats.) Jepson, Man. Fl. Pl. Calif. 298. 1923.

*Chorizanthe fernandina* Wats. Botany [of California] 2: 481. 1880; Parry, Proc. Davenp. Acad. Sci. 4: 61. 1884; Abrams, Fl. Los Angeles & Vicinity, 114. 1904, and ed. 2. 105. 1917; Jepson, Fl. Calif. 395. 1914, in synonymy; Davidson & Moxley, Fl. So. Calif. 113. 1923.

Involucral teeth straight or merely curved, divergent, sometimes widely so, outer commonly longer than the tube, inner very short. Otherwise as in the species.

Type: San Fernando Cañon, Los Angeles County, California, June, 1879, *Mrs. E. A. Bush* (G).

Distribution: Los Angeles and Orange Counties, California.

Specimens examined:

CALIFORNIA: LOS ANGELES COUNTY—San Fernando Valley, June, 1879, *Mrs. E. A. Bush* (CAS, US, isotypes); May, 1882, *Parry* (M, US); San Fernando, May 23, 1882, *Pringle* (M, Ph, US); Los Angeles River bed, April, 1884, *Lyon* (CAS); San Fernando Valley, June, 1887, *Parish 1987* (Par); Newhall, June 3, 1893, *Hasse* (D); Chatsworth Park, April 4, 1901, *Abrams 1337* (D, Pom, RMt); San Fernando Wash, May 11, 1913, *Eastwood 3139* (CAS, US); Little Tujunga Wash, San Fernando Valley, alt. 1100 ft., May 3, 1920, *Peirson 2120* (Pe); ORANGE COUNTY—Spring, 1902, *Geis* (D, Pom); hills near Santa Ana, Spring, 1902, *Geis 541* (D, Pom).

The geographic distribution of the variety, it will be noted, forms not merely an aspect of the species distribution, but an isolated area of its own. This area lies a little to the west of the north end of the range of the species. All specimens examined by the writer which possessed straight teeth were from the San Fernando region, whereas all the specimens from the geographic range of *C. Parryi* possessed the strongly downcurved or uncinate teeth.

**34. Chorizanthe inequalis** Stokes, Zoe 5: 60. 1900.

Diffuse plants; stems several from the base, slender, grayish ascending pubescent; leaves linear-oblanceolate, 2–4 cm. long, appressed-pubescent; lower bracts similar to the leaves, upper ones mostly acicular; inflorescence a loose cyme, the involucres in small clusters at the ends of the branches or solitary and sessile in the lower axils; involucres urceolate, more or less triangular in cross-section, 3.5–6 mm. long, ascending pubescent, the teeth divergent, straight, outer as much as 4 mm. or more long, inner very short; flower 2.5–3 mm. long, outer lobes less than half as long as the perianth, outer segments obovate to oblong-obovate, erose, inner linear-oblong to oblong-obovate, a little shorter, minutely erose; anthers elliptic.

Type: San Telmo, Baja California, May 31, 1893, *T. S. Brandegee* (UC).

Distribution: Lower California.

Specimens examined:

LOWER CALIFORNIA: Salada, April-May, 1886, *Orcutt 1369* (CAS, M, Par, US); April 17, 1886, *Orcutt* (US); San Quentin Bay, January, 1889, *Palmer 651* (Ph, US); San Telmo, May 31, 1893, *Brandegee* (M photograph, UC TYPE).

The morphology of the flower of this Lower Californian species is very similar to that of *C. Parryi* and its variety, but the involucres and the general aspect of the plant differentiate it sharply. The long involucral teeth give the plant a spiny appearance, and an aspect of gracefulness is attained because of the slender stems and long internodes.

Subsection 5. FLAVAE, new subsection. Erect to procumbent plants with basal leaves and usually non-foliaceous bracts. Involucres solitary and remote or in small clusters at the ends of the branches, about 5 mm. long, the awns infrequently uncinate, the inner teeth very short to obsolete. Flowers 5 mm. or more long, partially exserted. Perianth lobes similar or nearly so. Stamens 9. Species 35-37, incl.

Range: central Lower California.

The species included in this section have the most southern range of the North American representatives of the genus.

**35. Chorizanthe mutabilis** T. S. Brandegee, Proc. Cal. Acad. Sci. II. 2: 203. 1889. Pl. 1, fig. 12.

Plants erect or procumbent, 1–3 dm. long; stem solitary or few from the base, sparingly long-pubescent to glabrate, pale reddish; leaves narrowly lanceolate and long-petiolate, 1–2 cm.

over all, loosely tomentose below, long-pubescent above; bracts linear-lanceolate to acicular, hirsutulose to glabrate; inflorescence a uniparous cyme, the involucres solitary and remote, or more crowded at the ends of the branches; involucres, including the cylindric tube, 5 mm. long, ribs not reaching the base, sparingly pubescent, the larger teeth widely divergent, short and sometimes uncinate, the smaller set of teeth minute, some of the lower involucres a little longer, the larger teeth 3–4 mm. long, the awns short, straight or curved, the smaller divergent, 1 mm. long, a thin membrane appearing in the sinuses and frequently extending along the upper margins; flower cylindric, 6–7 mm. long, long-pubescent on the midveins above the middle, lobes linear-oblong, obtuse, entire or crenulate, about 2.5 mm. long, inner segments a little narrower; stamens adnate for a short distance to the perianth-tube, anthers oblong.

Type: San Enrique, Lower California, May 2, 1889, *T. S. Brandegee* (UC).

Distribution: near San Enrique, Lower California.

Specimens examined:

LOWER CALIFORNIA: San Enrique, May 2, 1889, *Brandegee* (CAS, M, Ph, Pom, US, isotypes).

This species, still so rare in herbaria, is well marked and easily recognized. Its nearest relative is *C. flava.* While it is probably unwise to designate one species as being more primitive than another in so small a subsection, nevertheless *C. mutabilis* is listed first, partly because its involucres are less modified than in *C. flava* and *C. pulchella.* These organs in the present species more nearly resemble the involucres of preceding subsections, and while the smaller trio of teeth are much reduced, they are not obsolete as they are in the other two species.

Brandegee states that the perianth tube in *C. mutabilis* is yellow and the segments white or rose color.

**36. Chorizanthe flava** T. S. Brandegee, Proc. Cal. Acad. Sci. II. 2: 202. 1889. Pl. 1, fig. 13.

*Chorizanthe Vaseyi* Parry & Rose, Bot. Gaz. 15: 64, *pl. 10.* 1890; Vasey & Rose, Contr. U. S. Nat. Herb. 1: 12. 1890.

Suberect or decumbent plants, a few cm. to 1.5 dm. or more high; stems several from the base, sparsely long appressed-pubescent; leaves spathulate, with a slender winged petiole, 1–5 cm. long, tomentose beneath, less densely so above, the midrib glabrate; bracts linear-lanceolate; inflorescence of elongated uniparous cymes, the involucres single and remote except at the ends of the branches; involucres subcylindric, ribs nearly lacking, 5 mm. long, tube 4 mm. long, curly-pubescent, the 3 larger teeth 3–5 mm. long, widely spreading, straight to falcate, one a little longer than the other two, inner teeth obsolete or nearly so, their positions taken instead by noticeable, hairy membranes; flower obconic, about 6 mm. long, minutely and sparsely pubescent, yellow, lobes 2 mm. long, linear-lanceolate, all similar; anthers short-oblong.

Type: Calmalli, Lower California, April 18, 1889, *T. S. Brandegee* (UC).

Distribution: region of Calmalli, Lower California.

Specimens examined:

LOWER CALIFORNIA: "40 miles from ocean, hilly country," Lagoon Head, March 6–15, 1889, *Palmer 775* (M, Par, US TYPE material of *C. Vaseyi*); Calmalli, April 18, 1889, *Brandegee* (M photograph, Ph isotype); plains, Calmalli, January–March, 1898, *Purpus 126* (D, US); plains, Calmalli, January–March, 1898, *Purpus* (D, US); margin of the Viscaino Desert, 39 miles north of San Ignacio, January 31, 1929, *Reed 6193* (Pom).

Brandegee's publication preceded that of Parry & Rose by four months. Ironically, the type of *C. Vaseyi* was collected a month before Brandegee collected his *C. flava.* A good illustration of the species accompanies the Parry & Rose publication.

In the original description of *C. Vaseyi,* the type is given as *Palmer 275* rather than *Palmer 775.* This is doubtless a typographic error.

**37. Chorizanthe pulchella** T. S. Brandegee, Proc. Cal. Acad. Sci. II. 2: 203. 1889.

Plants erect to spreading; stems several from the base, becoming reddish in age, only slightly branched, sparsely ascending pubescent; leaves ovate, acute, abruptly contracted at base to a long, winged petiole, blades less than 1 cm. long; bracts acerose, usually spreading; involucres disposed singly in loose, uniparous cymes, 5 mm. long, tube as long, cylindric, tomentose to glabrate, the 3 larger teeth widely spreading, falcate, longer than the tube, the inner erect, very short, scarcely exceeding the sinal membrane; flowers 9–12 mm. long, the tube yellow, lobes ovate-oblong in outline, deeply and numerously laciniate, reddish; anthers oval.

Type: San Sebastian, Lower California, April 28, 1889, *T. S. Brandegee* (UC).

Distribution: near San Sebastian, Lower California.

Specimens examined:

LOWER CALIFORNIA: San Luis, April 27, 1889, *Brandegee* (CAS); San Sebastian, April 28, 1889, *Brandegee* (CAS, Ph, isotypes, M photograph).

The reduction in the number of involucres at the branches of the cymes from several to one, the markedly arrested development of the smaller teeth of the involucre, and the laciniate condition of the perianth lobes are characters found in this species which indicate a comparatively highly evolved condition.

Subsection 6. PROCUMBENTES, new subsection. Diffuse to decumbent plants, stems several from the base, dichotomously branched, the leaves basal, and the lower bracts usually foliaceous. Inflorescence of compound, uniparous cymes. Involucres short (tube 2 or rarely 3 mm. long), with small, yellow membranes in the sinuses. Perianth lobes similar or nearly so, entire. The 9 stamens united by their filaments into a short, pilose-ciliate staminal tube. Species 38–40, incl.

Range: Los Angeles County, California, south into Lower California.

**38. Chorizanthe procumbens** Nutt. Jour. Acad. Phila. N. S. **1**: 167. 1848; Benth. in DC. Prodr. **14**: 26. 1857; Gray, Proc. Bost. Soc. Nat. Hist. **7**: 148. 1859, as to name only; Torr. & Gray, Proc. Am. Acad. **8**: 195. 1870; Wats. U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 484. 1871; Wats. Proc. Am. Acad. **12**: 271. 1877; Wats. Botany [of California] **2**: 37. 1880; Parry, Proc. Davenp. Acad. Sci. **4**: 60. 1884; Dammer in

Engl. & Prantl, Nat. Pflanzenfam. $3^{1a}$: 12. 1891; Abrams, Fl. Los Angeles & Vicinity, 114. 1904, and ed. 2. 104. 1917; Jepson, Fl. Calif. 395. 1914; Davidson & Moxley, Fl. So. Calif. 113. 1923; Jepson, Man. Fl. Pl. Calif. 298. 1923.

*Chorizanthe uncinata* Nutt. Jour. Acad. Phila. N. S. **1**: 167. 1848; Benth. in DC. Prodr. **14**: 26. 1857, in synonymy; Torr. & Gray, Proc. Am. Acad. **8**: 195. 1870, in synonymy.

Procumbent or diffuse plants, 3–15 cm. high; stems curly ascending pubescent; leaves spathulate-oblanceolate to oblong, 2–7 cm. long including the slender petioles, long and densely pubescent beneath, at least when young, more sparsely pubescent to glabrate above; lower bracts frequently foliaceous and similar to the leaves, upper bracts acerose; the involucres aggregated into small clusters, short, 2–2.5 mm. long, pubescent to sparsely so, the tube cylindric, 6-ribbed, about 2 mm. long, the 6 teeth widely divergent, their tips down-curved or uncinate, the 3 larger as long as the tube, the inner a little shorter; flower partly exserted, cylindric, 1.5–2 mm. long, yellow, the lobes oblong (or the inner sometimes ovate), obtuse, a third to a half as long as the tube, the inner slightly smaller, an appressed, scanty pubescence along the midveins; stamens just included, anthers oblong, very small.

Type: "St. Diego, Upper California," coll. of 1836, *Nuttall* (Ph).

Distribution: western San Bernardino and Riverside Counties, Los Angeles County, California, and southward to Lower California.

Specimens examined:

CALIFORNIA: SAN BERNARDINO COUNTY—Colton, 1881, *Parry 270* (G, Par, US); Colton, May 8, 1881, *Parry* (G); mesas, San Bernardino Valley, April 29, 1888, *Parish Bros. 826* (D, ISC, M, US); vicinity of San Bernardino, alt. 1000-1500 ft., May 20, 1895, *Parish 3663* (G, US); east of Upland, alt. about 1000 ft., June 11, 1927, *Howell 2481* (CAS); RIVERSIDE COUNTY—Cabazon, April, 1891, *Orcutt* (M); LOS ANGELES COUNTY—Pasadena, May 2, 1882, *Jones* (Pom); Roscoe, May 27-June 10, 1906, *Eastwood 258* (CAS, G); San Fernando Wash, May 11, 1913, *Eastwood* (CAS); dry wash in chaparral, Claremont, May 13, 1919, *Munz 2790* (D, Pom); Arroyo Seco, San Gabriel Mts., alt. 1250 ft., May 20, 1919, *Peirson 446* (Pe); Santa Anita Wash, San Gabriel Mts., alt. 700 ft., April 26, 1920, *Peirson 4212* (Pe); mountains near Claremont, May 21, 1926, *Jones* (US); Thompson

Creek Dam near Claremont, alt. 1600 ft., May 27, 1932, *Wheeler 766* (M); SAN DIEGO COUNTY—San Diego, 1836, *Nuttall* (G isotype, M photograph, Ph isotype, US photograph); San Diego, 1836, *Nuttall* (G fragment of TYPE of *C. uncinata*, Ph TYPE of *C. uncinata*, US photograph); San Diego, 1874, *Cleveland* (G); San Diego, 1875, *Palmer 135* (US); San Diego, June, 1875, *Palmer 354* (M); 1880, *Vasey 542* (G, US); San Diego, 1882, *Parry 270* (G, M, Par); Soledad, April 20, 1882, *Jones 3159* (CAS, D, M, Pom, US); San Diego, May, 1882, *Parry* (Par); San Diego, 1884, *Orcutt* (Par); Point Loma, March 28, 1884, *Parry* (Par); mesas, San Diego, May 8, 1884, *Orcutt* (M); San Diego, May 15, 1885, *Orcutt* (US); San Diego, April 24, 1891, *Dunn* (D); Coronado, May 5, 1891, *Dunn* (US); San Ysabel, April 28, 1893, *Henshaw* (US); Witch Creek, June, 1894, *Alderson* (D); San Diego, June, 1895, *Stokes* (D); Point Loma, April, 1896, *K. Brandegee* (D); San Diego, May, 1901, *K. Brandegee* (US); San Diego, May 25, 1902, *Brandegee 1638* (G, M, Pom, RMt, US); Coronado, *Grant 2607* (D); near Potrero, June 3, 1903, *Abrams 3737* (D, G, M, Ph, Pom); San Diego, April, 1905, *Brandegee* (US); San Diego, May 5, 1906, *Grant 6818* (D); sandy hills, Point Loma, June, 1906, *K. Brandegee 29* (D, G, M, Ph, Pom, RMt, US); Point Loma, April 21, 1913, *Eastwood 2874* (CAS, G, US); La Jolla, May 23, 1914, *Clements & Clements 49* (G, M, Ph); Otay Mesa, near San Diego, June 14, 1915, *Collins & Kempton 183* (US); sandy slopes, Granite, alt. 2000 ft., May 30, 1916, *Spencer 33* (G, US); Alpine, June 27, 1923, *Munz & Harwood 7146* (Pom, RMt); sandy soil, Cardiff, May 9, 1924, *Munz 7958* (Pom).

LOWER CALIFORNIA: Tecate River, June 23, 1894, *Schoenfeldt 3716* (US).

The yellow, triangular membrane in the sinuses between the teeth furnishes a ready means of distinguishing this species from its immediate allies. This character may be seen readily by the aid of a binocular dissecting microscope when the involucres have been pressed in such a way as to open the sinus and stretch the membrane. The yellowish-green color of all except the last member of this subsection is also characteristic.

The lower bracts of *C. procumbens* are sometimes bract-like rather than foliaceous, or are lacking in herbarium specimens. Foliaceous bracts are not mentioned in Nuttall's original description, and Watson[44] and Parry[45] state that the bracts are not foliaceous.

The inner teeth of the involucre are smaller than those of the outer 3, but there is not the disparity in size which occurs in many of the species.

Nuttall's *C. uncinata* is itself distinguishable from the type

[44] Wats. Proc. Am. Acad. 12: 271. 1877, and Botany [of California] 2: 33, 37. 1880.

[45] Parry, Proc. Davenp. Acad. Sci. 4: 60. 1884.

of *C. procumbens* in that the involucral teeth are longer and more uncinate, and the involucres are less pubescent. However, the series of specimens examined present so many intermediates between the two extremes that it seems impossible to give *uncinata* recognition.

**38a. Chorizanthe procumbens** Nutt. var. **albiflora** Goodman, n. var.[46]

Similar to the species but the flowers white.

Type: dry slope 2 miles east of Pala, San Diego County, California, April 30, 1926, *Munz 10372* (Pom).

Distribution: northern San Diego County, California.

Specimens examined:

CALIFORNIA: SAN DIEGO COUNTY—Pala, June, 1880, *Vasey 542* (US); near Fallbrook, May 15, 1920, *Munz & Harwood 3897* (Ph, Pom); near Pala, June 21, 1922, *Munz 8192* (Pom); southeast of Pala, alt. 800 ft., June 21, 1924, *Peirson 4766* (Pe); dry slope, 2 miles east of Pala, April 30, 1926, *Munz 10372* (M photograph, Pom TYPE); near Pala, April 30, 1926, *Peirson 6692* (Pe); wash, south of Pala, April 20, 1928, *Reed 5827* (CAS); above Rincon, Palomar Mts., June 14, 1928, *Wiggins 3090* (D); sandy flats, east of Pala, May 11, 1930, *Howell 4856* (CAS).

**38b. Chorizanthe procumbens** Nutt. var. **mexicana** Goodman, n. var.[47]

Small plants, 2 to few cm. tall, the foliaceous bracts seemingly early deciduous; involucral teeth very slender and uncinate; flowers 2 mm. long, yellowish to whitish, lobes equal, broadly ovate to broadly elliptic-oblong, about 0.75 mm. long; otherwise similar to the species.

Type: open spaces in chaparral, Tecate, Lower California, alt. 600 m., May 30, 1932, *F. R. Fosberg 8281* (M).

Distribution: northwestern Lower California.

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[46] **Chorizanthe procumbens** Nutt. var. **albiflora** Goodman, var. nov., similis speciei, sed floribus albis.—Dry slope, 2 miles east of Pala, San Diego County, California, April 30, 1926, *Munz 10372* (Pom TYPE).

[47] **Chorizanthe procumbens** Nutt. var. **mexicana** Goodman, var. nov. Planta parva, 2 vel pauca cm. alta; involucri dentibus tenuissimis et uncinatis; floribus 2 mm. longis, flavescentibus vel albidis, laciniis aequalibus, late ovatis vel late elliptico-oblongis, circiter 0.75 mm. longis. Cetera speciei similis.—Open spaces in chaparral, Tecate, Lower California, alt. 600 m., May 30, 1932, *F. R. Fosberg 8281* (M TYPE).

Specimens examined:

LOWER CALIFORNIA: All Saints Bay, April, 1882, *Fish* (G); Tecate, alt. 600 m., May 30, 1932, *Fosberg 8281* (M TYPE).

The broad lobes of this variety suggest *C. Jonesiana*, but the short branches of the inflorescence and the slender teeth of the involucres ally it more closely to *C. procumbens*.

**39. Chorizanthe Jonesiana** Goodman, n. sp.[48]

Pl. 2, fig. 2.

Decumbent plants; stems several from the base, 1–2 dm. long, sparsely curly ascending pubescent; leaves petiolate, oblanceolate, 2–4.5 cm. long, sparsely pubescent; lower bracts similar to the leaves, upper lanceolate-acicular; the long branches of the uniparous cymes 2–3 cm. long, the involucres solitary or in scattered clusters, 6-ribbed, 3–4 mm. long, tube 2–3 mm. long, campanulate, sparsely spreading pubescent, the awned portion of the teeth short and uncinate, the larger set arcuate, widely divaricate, and as long as or longer than the tube; inner much smaller, the small yellow membrane in the sinuses apparent; flower partially exserted, obconic, about 3 mm. long, glabrate, white, lobes elliptic-obovate, a third as long as the tube, inner scarcely smaller; the 9 stamens united into a short, pilose-ciliate tube, anthers linear-oblong.

Type: ranch, 29 miles southwest of Tia Juana, Lower California, April 13, 1925, *M. E. Jones* (Pom.)

Distribution: northwestern Lower California.

Specimens examined:

LOWER CALIFORNIA: Ensenada, April 12, 1882, *Jones* (Pom); April 11, 1882,

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[48] **Chorizanthe Jonesiana** Goodman, sp. nov. Planta decumbens; caulibus pluribus e base, 1–2 dm. longis, sparse adscendente pubescentibus; foliis petiolatis, oblanceolatis, 2–4.5 cm. longis, sparse pubescentibus; bracteis inferioribus foliis similibus, superioribus lanceolato-acicularibus; ramis cymarum uniparitarum 2–3 cm. longis; involucris solitariis vel in glomerulis laxis, 6-costatis, 3–4 mm. longis, tubo campanulato, 2–3 mm. longo, divergente pubescente, spinis dentium brevibus et uncinatis, majoribus 3 arcuatis, late divaricatis, tubum adaequantibus vel superantibus, alternatis multum parvioribus; floribus paulo exsertis, obconicis, circiter 3 mm. longis, glabratis, albis, laciniis elliptico-obovatis, 0.75 mm. longis, interioribus vix parvioribus; staminibus 9, in tubum brevem pilosum conjunctis; antheris lineari-oblongis.—Ranch, 29 miles southwest of Tia Juana, Lower California, April 13, 1925, *M. E. Jones* (Pom TYPE).

*Jones* (Pom); May 29, 1883, *Orcutt 877* (G); ranch, 29 miles southwest of Tia Juana, April 13, 1925, *Jones* (D, M photograph, Pom TYPE).

The long internodes of the inflorescence, the thickened involucral teeth with short awns, and the white flowers serve to readily distinguish *C. Jonesiana* from its nearest relative, *C. procumbens.* The broader lobes of the perianth form a most important, though hidden, difference between the two species. In young flowers of *C. Jonesiana* the inner lobes have been observed to be orbicular-obovate.

### 40. **Chorizanthe chaetophora** Goodman, n. sp.[49]

Pl. 2, fig. 1.

Plants spreading, only slightly branched, 1–1.5 dm. long, grayish with a loosely appressed pubescence; leaves petiolate, oblanceolate, obtuse to rounded, about 3 cm. long, shortly villous; lower bracts similar to the leaves, reduced above, the upper small and linear; involucres arranged in small clusters along a compound uniparous cyme, gray with appressed pubescence, tube campanulate, 2 mm. long, the 3 larger teeth widely spreading, arcuate, 2–3 mm. long, thickened toward the base, spines cuspidate, short, nearly straight, inner short and spreading, membranes of the sinuses yellow but inconspicuous; flowers narrowly obconic, 2.5 mm. long, slightly pubescent on the outer surface, the hairs surpassing the perianth lobes, these yellow, equal, short (0.5 mm. long), oblong; filaments united into a short, ciliate tube, anthers oblong.

Type: San Quentin Bay, Lower California, January, 1889, *Palmer 652* (Ph).

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[49] **Chorizanthe chaetophora** Goodman, sp. nov. Planta diffusa, ramosiuscula, 1–1.5 dm. longa, cinerea, laxe appresso-pubescens; foliis petiolatis, oblanceolatis, obtusis vel rotundatis, circiter 3 cm. longis, breve villosis; bracteis inferioribus foliis similibus, superioribus parvioribus, linearibus; involucris in glomerulis parvis in cyma composita uniparita dispositis, cinereo-appresso-pubescentibus, tubo campanulato, 2 mm. longo, 3 majoribus dentibus late divergentibus, arcuatis, 2–3 mm. longis, ad basem crassulatis, spinis dentium cuspidatis, brevibus, subrectis, inferioribus brevibus et divergentibus, sinorum membranis flavis sed inconspicuis; floribus anguste obconicis, 2.5 mm. longis, exteriore pubescentculis, pilis perigonii lacinias superantibus, flavis, laciniis aequalibus, brevibus (0.5 mm. longis), oblongis; filamentis in tubum brevem ciliatum conjunctis, antheris oblongis.—San Quentin, Lower California, January, 1889, *Palmer 652* (Ph TYPE).

Distribution: near San Quentin, Lower California.

Specimens examined:

LOWER CALIFORNIA: San Quentin Bay, January, 1889, *Palmer 652* (G, M photograph, Ph TYPE, US).

This species is most nearly related to *C. procumbens* var. *mexicana*, but differs chiefly in the large, thick teeth of the involucre, and in the gray pubescence of the stems and involucres. *Chorizanthe chaetophora* superficially simulates to a remarkable degree *C. inequalis* of the Parryanae subsection.

The specific appellation is in allusion to the pubescence of the perianth which, so far as present observation shows in this subsection, uniquely exceeds the perianth lobes.

### DIAGNOSIS OF ERIOGONELLA, NEW GENUS

In the course of transferring to other genera several species heretofore usually considered as members of *Chorizanthe*, it was discovered that two of these species, *C. membranacea* and *C. spinosa*, could not correctly be referred to any known genus. Below, under "Species Excluded," they are properly referred to the following genus:

**Eriogonella** Goodman, n. gen. of the Polygonaceae.[50] Annual plants, softly pubescent to tomentose. Stems erect or prostrate, dichotomously branched. Leaves basal or nearly so, and entire. Inflorescence cymose. Bracts opposite or verticillate, entire. Involucres sessile, urceolate, 5–6-ribbed and -toothed, the teeth spine-tipped. Flowers 2 or 3 in an involucre, but only one developing, pedicellate, bractlets lacking; perianth 6-parted, the outer segments larger than the inner 3, all entire. Stamens 9, inserted at the base of the perianth.

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[50] **Eriogonella Goodman**, gen. nov. Polygonacearum. Plantae annuae, molliter pubescentes vel tomentosae. Caules erecti aut prostrati, dichotome ramosi. Folia basalia vel subbasalia et integra. Inflorescentia cymosa. Bracteae oppositae aut verticillatae, integrae. Involucra sessilia, urceolata, 5–6-costata dentataque, dentibus in spinis terminatis. Flores 2–3 in involucro (uno flore maturante), pedicellati; bracteoli nulli; perianthum 6-partitum, segmentis integris, exterioribus interioribus 3 majoribus. Stamina 9, ad basem perianthi inserta. Achaenium 3-carpellatum, 3-angulatum; styli 3; stigmatae capitatae; radicula curvata, cotyledones suborbiculati et accumbenti.

Achene 3-carpellate, 3-angled, styles 3, stigmas capitate; radicle curved, the cotyledons suborbicular and accumbent.

Type species: *Eriogonella membranacea* (Benth.) Goodman.

## SPECIES EXCLUDED

*C. californica* (Benth.) Gray, Proc. Bost. Soc. Nat. Hist. 7: 149. 1859 = **Mucronea californica** Benth. Trans. Linn. Soc. Lond. **17**: 419, *pl. 20.* 1836.

*C. californica* (Benth.) Gray var. *Suksdorfii* Macbride, Contr. Gray Herb. N. S. **53**: 6. 1918 = **Mucronea californica** Benth. var. **Suksdorfii** (Macbr.) Goodman, n. comb.

*C. floccosa* Jones, Contr. West. Bot. **12**: 74. 1908 = **Hollisteria lanata** Wats. Proc. Am. Acad. **14**: 296. 1879.

*C. insignis* Curran, Bull. Cal. Acad. Sci. **1**: 275. 1885 = **Oxytheca insignis** (Curran) Goodman, n. comb.

*C. leptoceras* (Gray) Wats. Proc. Am. Acad. **12**: 269. 1877 = **Centrostegia leptoceras** Gray, Proc. Am. Acad. **8**: 192. 1870.

*C. membranacea* Benth. Trans. Linn. Soc. Lond. **17**: 419, *pl. 17, fig. 11.* 1836. = **Eriogonella membranacea** (Benth.) Goodman, n. comb.

*C. perfoliata* Gray, Proc. Bost. Soc. Nat. Hist. **7**: 148. 1859 = **Mucronea perfoliata** (Gray) Heller, Muhlenbergia **2**: 23. 1905.

*C. polygonoides* Torr. & Gray, Proc. Am. Acad. **8**: 197. 1870 = **Acanthogonum polygonoides** (T. & G.) Goodman, n. comb.

*C. rigida* (Torr.) Torr. & Gray, *l. c.* 198. 1870 = **Acanthogonum rigidum** Torr. Pacif. R. R. Rept. **4**: 133. 1856.

*C. spinosa* Wats. Botany [of California] **2**: 481. 1880 = **Eriogonella spinosa** (Wats.) Goodman, n. comb.

*C. Thurberi* (Gray) Wats. Proc. Am. Acad. **12**: 269. 1877 = **Centrostegia Thurberi** Gray ex Benth. in DC. Prodr. **14**: 27. 1857.

*C. Thurberi* (Gray) Wats. var. *cryptantha* Curran, Bull. Cal. Acad. Sci. **1**: 275. 1885 = **Centrostegia Thurberi** Gray ex Benth, *l.c.* 1857.

*C. Vortriedei* T. S. Brandegee, Zoe **4**: 158. 1893 = **Centrostegia Vortriedei** (T. S. Brandegee) Goodman, n. comb.

## List of Exsiccatae

The collectors' numbers are printed in *italics*, or, if the collection is unnumbered, it is indicated by a dash. The numbers in parentheses indicate the number assigned to the species in this revision.

Abbott, E. K. — (14); — (29).

Abrams, Mrs. J. D. — (21); — (33).

Abrams, L. R. *3169, 11016, 11060* (1); *11754, 11932a,* (3); *3222* (5); *1218* (7); *1603* (9a); *6516* (10a); *1653* (11); *4047, 4283* (14); *7443* (16); *205, 1274, 1807, 2554, 2637, 4116* (18); *1708* (18a); *3777* (21); *3426* (25); *3661* (26); *7655* (30); *1337* (33a); *3737* (38).

Abrams, L. R. & E. A. McGregor. *146* (18a); *305* (20).

Abrams, L. R. & I. L. Wiggins. *66* (24).

Alderson, R. D. — (21); — (38).

Andrews, T. L. *13, 14* (14).

Angier, B. S. *184* (25).

Antisell, T. — (26).

Austin, Mrs. R. M. — (17).

Bacigalupi, R. *1491* (8a); *1490* (11).

Baker, C. F. *1092* (3); *2842, 5072* (9); *4706* (18).

Baker, M. S. *3097b, 5360* (31).

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## Explanation of Plate

### PLATE 1

Fig. 1. Involucre of *Chorizanthe glabrescens.* × 6.

Fig. 2. Flower of *Chorizanthe glabrescens.* × 6.

Fig. 3. Involucre of *Chorizanthe Orcuttiana.* × 5.

Fig. 4. Involucre of *Chorizanthe corrugata.* × 5.

Fig. 5. Dorsal and lateral views of embryo of *Chorizanthe corrugata.* × 5.

Fig. 6. Involucre of *Chorizanthe staticoides.* × 8. Dotted lines indicate exserted portion of the perianth.

Fig. 7. Perianth of *Chorizanthe staticoides,* laid open. × 8.

Fig. 8. Involucre of *Chorizanthe valida.* × 10.

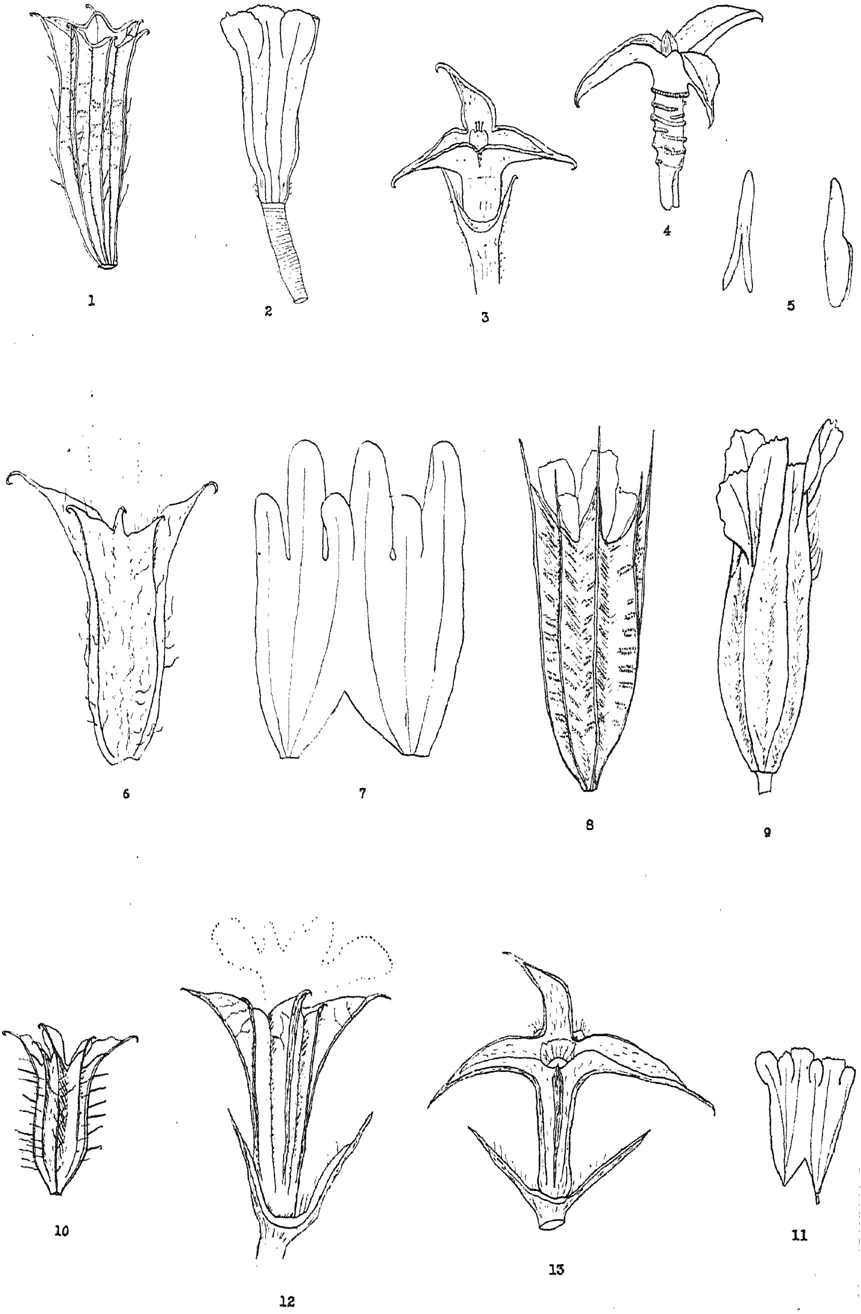
Fig. 9. Flower of *Chorizanthe valida.* × 10.

Fig. 10. Involucre of *Chorizanthe pungens.* × 6.

Fig. 11. Perianth of *Chorizanthe pungens,* laid open. × 6.

Fig. 12. Involucre of *Chorizanthe mutabilis.* × 6. Dotted line indicates exserted portion of the perianth.

Fig. 13. Involucre of *Chorizanthe flava.* × 6.



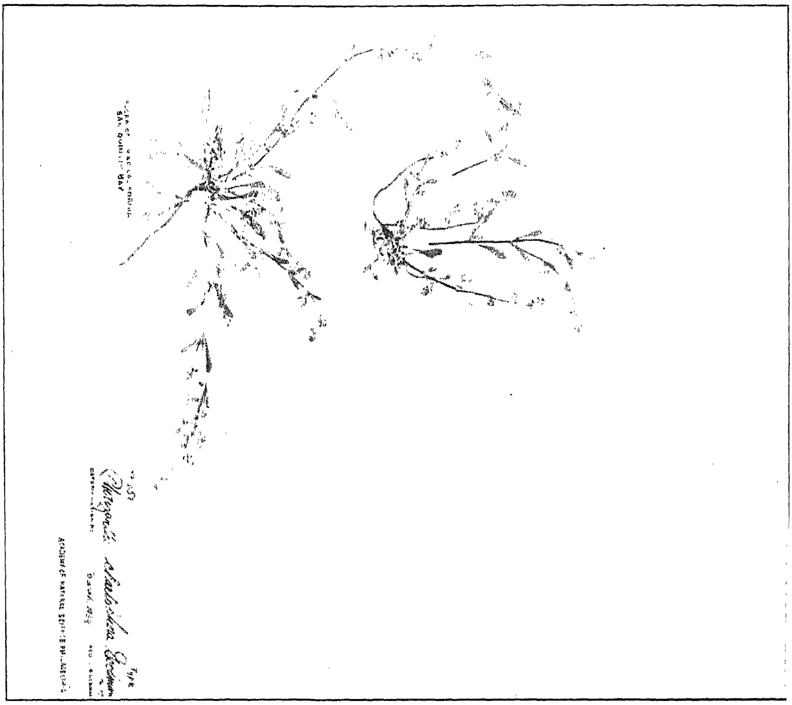
GOODMAN—NORTH AMERICAN SPECIES OF CHORIZANTHE

## Explanation of Plate

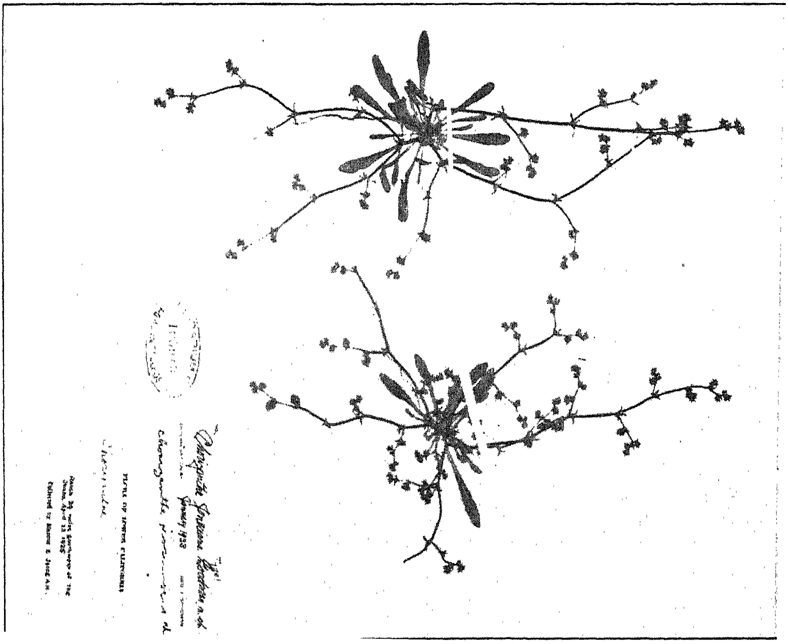
### PLATE 2

Fig. 1. *Chorizanthe chaetophora* Goodman. From the type specimen, *Palmer 652,* in the Herbarium of the Academy of Natural Sciences of Philadelphia.

Fig. 2. *Chorizanthe Jonesiana* Goodman. From the type specimen, *M. E. Jones,* in the Herbarium of Pomona College.



1



2

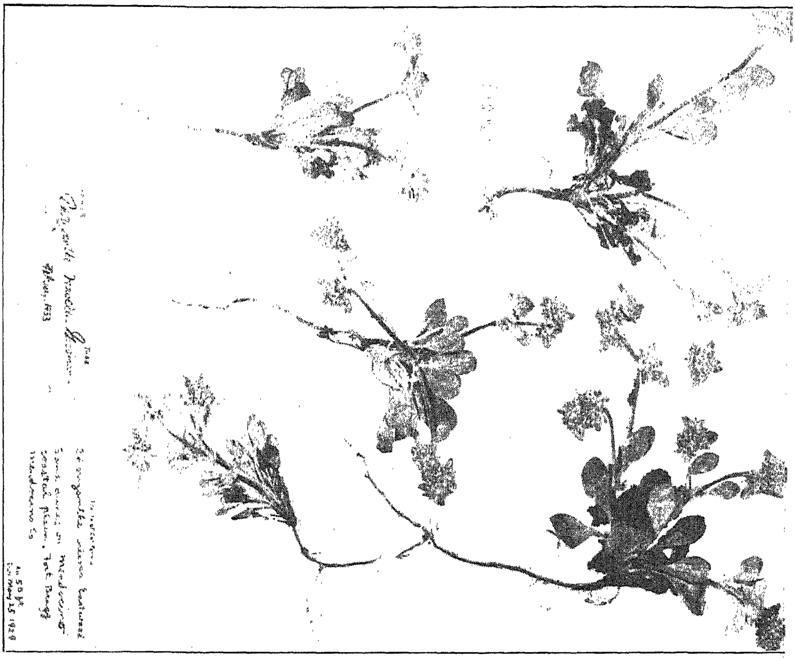
GOODMAN—NORTH AMERICAN SPECIES OF CHORIZANTHE

## EXPLANATION OF PLATE

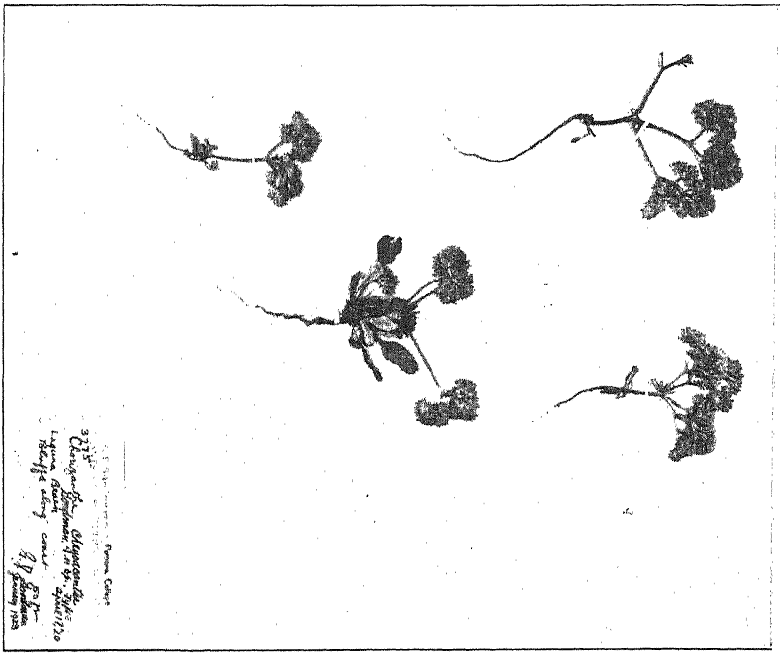
### PLATE 3

Fig. 1. *Chorizanthe Howellii* Goodman. From the type specimen, *J. T. Howell 4233,* in the Herbarium of the California Academy of Sciences.

Fig. 2. *Chorizanthe chrysacantha* Goodman. From the type specimen, *Munz & Harwood 3775,* in the Herbarium of Pomona College.



1



2

GOODMAN—NORTH AMERICAN SPECIES OF CHORIZANTHE

# A MONOGRAPH OF THE GENUS MENTZELIA[1]

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## HISTORY

The genus *Mentzelia,* named for Christian Mentzel, a German botanist of the early seventeenth century, was first described by Plumier[2] in 1703 from a plant collected by him in the West Indies (1689-91). The specimen on which the generic description was based was given the scientific name, *Mentzelia aspera,* by Linnaeus[3] in 'Species Plantarum,' 1753, and constitutes the type species for the genus. Willdenow,[4] in 1799, added one new species, namely, *hispida.* In 1804 a new family, Loasaceae, was described by Jussieu,[5] based on the two genera, *Mentzelia* and *Loasa.* Previous to this date, these two genera had been included by the majority of botanists in the *Onagraceae.*

A new genus, *Bartonia,* closely related to *Mentzelia,* was published by Sims,[6] in 1812, from plants sent by Thomas Nuttall[7] from western North America. The communication, including the description of one species, *decapetala,* was made by Pursh.[8] A new species, *Mentzelia oligosperma,* was listed in Fraser's Catalogue[9] in 1813, a detailed description appearing two years later.[10]

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[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

[2] Plumier, C., Nov. Pl. Am. Gen. 40. 1703.

[3] Linnaeus, C., Sp. Pl. ed. 1. 516. 1753.

[4] Willdenow, C. L., Sp. Pl. $2^2$: 1175. 1799.

[5] Jussieu, A., Ann. Mus. Nat. Hist. 5: 18. 1804.

[6] Sims, J., in Bot. Mag. *pl. 1487.* 1812.

[7] Nuttall, T., Gen. 1: 297. 1818.

[8] Pursh, F., Fl. Am. Sept. 1: 327. 1814, as *B. ornata.*

[9] Fraser, Cat. Pl. 1813 [reprinted in Pittonia 2: 116. 1890].

[10] Nuttall, T., in Sims, Bot. Mag. 42: *pl. 1760.* 1815.

Issued April 12, 1934.

Though the genus *Bartonia* Sims was retained for a number of years as a valid genus of the *Loasaceae* and various new species described under it, the generic name *Bartonia* was first used by Willdenow[11] in 1801 for a plant belonging to the *Gentianaceae.*

A great deal of confusion arose concerning the correct authority for two species published as *Bartonia ornata* and *B. nuda* Pursh. They were described first by Pursh,[12] in 1814, from plants collected by Nuttall in the region of the upper Missouri. Later, Nuttall[13] described the same two species as new in 1818. Various persons have listed these two species, *ornata* and *nuda,* as belonging to either Nuttall or Pursh. Rafinesque,[14] aware that *Bartonia* had been used earlier to designate a group of plants in another family, proposed the name *Nuttallia* for that of the previously used *Bartonia.* The generic name was not taken up as a valid genus until a number of years later.

The first Mexican and South American species of *Mentzelia* to be described were *strigosa* and *scabra,* in 1823, from collections made by Humboldt and Bonpland.[15] When De Candolle's 'Prodromus' appeared in 1828,[16] six species of *Mentzelia,* including a new one from Mexico, *stipitata,* and two species of *Bartonia* were given.

A new generic segregate, *Acrolasia,* was proposed in 1835, by Presl,[17] with one species, *bartonioides.* In Don's[18] taxonomic treatment of the genus, 1834, the two genera *Mentzelia* and *Bartonia* were maintained with a total of fourteen species. Spach,[19] in 1838, recognized the three genera, *Acrolasia* Presl, *Bartonia* Pursh, and *Mentzelia* L., and placed them under Section 1. *Bartonineae* of the family *Loasaceae.*

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[11] Willdenow, C. L., Ges. Naturf. Freunde Berlin, Neue Schrift. **3:** 444–445. 1801.

[12] Pursh, F., Fl. Am. Sept. **1:** 327, 328. 1814.

[13] Nuttall, T., Gen. **1:** 299. 1818.

[14] Rafinesque, C., in Am. Month. 175. 1818

[15] Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. **6:** 95–96. 1823.

[16] De Candolle, A. P., Prodr. **3:** 343. 1828.

[17] Presl, K. B., Reliq. Haenk. **2:** 39, *pl. 55.* 1835.

[18] Don, G., Hist. Dichl. Pl. **3:** 65. 1834.

[19] Spach, E., Hist. Nat. Veg. **6:** 236–240. 1838.

Two other generic segregates, *Creolobus*[20] in 1839 and *Chrysostoma*[21] in 1840, were published by Lilja and almost immediately reduced to synonymy under *Mentzelia.*

In 1834, Hooker,[22] in going over the Douglas manuscript, found three new species which he published, namely, *laevicaulis, parviflora,* and *albicaulis,* under *Bartonia.* Douglas was uncertain whether or not *albicaulis* should belong to *Bartonia* or to *Mentzelia.* In 1840 Torrey and Gray[23] gave the first comprehensive treatment of the group of North American species. The generic name of *Mentzelia* was retained and *Acrolasia, Bartonia,* and a new generic segregate of Nuttall, *Trachyphytum,* were all reduced to synonymy. At this time twelve species were given, including five new ones under three sections, *Eumentzelia, Trachyphytum,* and *Bartonia* of Nuttall, not Willdenow.

In 1840 Eaton and Wright[24] published the name *Touterea* and referred to it two species, *ornata* and *nuda.* These names were soon reduced to synonymy under *Mentzelia.* Three years later, Walpers[25] recognized *Acrolasia, Bartonia,* and *Mentzelia,* as genera of equal rank; and under the latter he indicated three sections, *Eumentzelia, Trachyphytum,* and *Microsperma,* together including ten species. Two new South American species *Mentzelia chilensis* and *Acrolasia Solierii,* were added by Gay[26] in 1846. The following year Hooker[27] listed five species, including a new one, *micrantha,* together with a great deal of synonymy.

The next few years, following various explorations, chiefly in the Southwest, resulted in the publication of several heretofore undescribed species. In 1850, Gray[28] definitely placed *Microsperma* as a synonym under *Eucnide,* removing it from

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[20] Lilja, N., Fl. öfver Sver. odl. Vext. 67. 1839.

[21] Lilja, N., Fl. öfver Sver. odl. Vext. Suppl. 1: 33. 1840.

[22] Hooker, W. J., Fl. Bor. Am. 1: 221-222. [1834] 1840.

[23] Torrey, J. and Gray, A., Fl. N. Am. 1: 534-537. 1840.

[24] Eaton, A. and Wright, J., N. Am. Bot. 454. 1840.

[25] Walpers, G. G., Rep. Bot. Syst 2: 224. 1843.

[26] Gay, C., Fl. Chile 2: 431. 1846.

[27] Hooker, W. J., Lond. Jour. Bot. 6: 226. 1847.

[28] Gray, A., Boston Jour. Nat. Hist. [Pl. Lindheimeri, pt. 2] 6: 191. 1850.

*Mentzelia*, with which it had been confused. The period from 1876 to 1900 added a number of new species. Urban and Gilg's[29] monographic treatment of the *Loasaceae* appeared in 1900. Seven sections, some of them new, were maintained under the genus *Mentzelia*, comprising in all forty-seven species of North and South America, fourteen of the group newly described.

Cockerell, in 1901,[30] added another generic segregate, *Hesperaster*, transferring thereto several species from *Mentzelia*. The following year Osterhout[31] described two new species under the generic name *Hesperaster*. Rydberg[32] revised the genus *Mentzelia*, maintaining *Acrolasia* and *Touterea* and adding a new genus, *Bicuspidaria*, all of which were given equal generic rank with *Mentzelia*.

*Nuttallia* of Rafinesque was reinstated as a good genus in 1906 by Dr. Greene.[33] The same year Davidson[34] made an incomplete revision of some of the western species of *Mentzelia*. This was followed a few years later by an excellent treatment of the section *Trachyphytum* by Macbride.[35]

Since the publication of Urban and Gilg's monograph in 1900, several species have been published as new to science. The five genera, *Acrolasia*, *Nuttallia*, *Touterea*, *Biscuspidaria*, and *Mentzelia*, have been kept as valid genera by certain authorities, especially in some of the manuals and local floras.

It has been the aim of the writer to bring together as completely as possible all the historical data relating to the genus, as well as the results of a critical study of recent collections, thereby clarifying synonymy and also establishing the natural relationships of the various entities concerned.

The writer is indebted to Dr. George T. Moore, Director of the Missouri Botanical Garden, where this study was under-taken, for the privilege of using the library and herbarium. She extends especial thanks and appreciation to Dr. J. M. Greenman for his kindly interest and supervision throughout the preparation of this monograph. The writer also wishes to thank Dr. Roland V. La Garde and Mr. Ward M. Sharp for the photographs taken in connection with the illustrations used in this paper. Grateful appreciation is extended to those in charge of the following herbaria for the generous loans of material necessary for this study: the United States National Museum; the Field Museum of Natural History; Kew Herbarium; the Natural History Museum of Vienna; the California Academy of Sciences; University of California Herbarium; the Dudley Herbarium of Leland Stanford Jr. University; the Academy of Natural Sciences of Philadelphia; Pomona College Herbarium; the Rocky Mountain Herbarium, University of Wyoming; Frank W. Peirson Herbarium; University of Michigan Herbarium; University of Arizona Herbarium; University of Montana Herbarium.

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[29] Urban, I. & Gilg, E., Monographia Loasacearum. Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 22–97, 356–358. 1900.

[30] Cockerell, T. D. A., in Torreya **1**: 142. 1901.

[31] Osterhout, G., in Bull. Torr. Bot. Club **29**: 174. 1902.

[32] Rydberg, P. A., in Bull. Torr. Bot. Club. **30**: 275. 1903.

[33] Greene, E. L., Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

[34] Davidson, A., in Bull. So. Calif. Acad. Sci. **5**: 14. 1906.

[35] Macbride, J. F., in Contr. Gray Herb. N. S. **56**: 24–28. 1918.

## ABBREVIATIONS

The following abbreviations have been used in citations to indicate the different herbaria from which material has been obtained for study:

A = University of Arizona Herbarium.
ANSP = The Academy of Natural Sciences of Philadelphia.
C = University of California.
CAS = California Academy of Sciences.
D = Dudley Herbarium of Leland Stanford Jr. University.
F = Field Museum of Natural History.
K = Kew Herbarium.
M = Missouri Botanical Garden.
MH = University of Michigan Herbarium.
P = Pomona College.
PH = Frank W. Peirson Herbarium.
RM = Rocky Mountain Herbarium, University of Wyoming.

UM = University of Montana.
US = United States National Museum.
V = Natural History Museum of Vienna.

## General Morphology

The genus *Mentzelia* includes annual or perennial, rarely biennial, herbaceous plants, which become ligneous or often suffruticose. The latter condition is characteristic of a few species of the *Eumentzelia* section.

*Roots.*—The annuals have a small tap-root with small lateral roots. The perennial species usually have a strong woody root, rarely a creeping rootstalk, more or less fusiform or thickened.

*Stems.*—The stems are erect or decumbent at the base, simple or branched below, few to several, often caespitose. The annuals assume a slender appearance, whereas the perennials are ordinarily stouter, coarser, and large. The stem may be glabrous, especially the older parts, or with varying degrees of hirsute pubescence. The bark or outer epidermis often appears shining white, breaking and disintegrating readily. The white stems are characteristic of a number of species, especially in the section *Trachyphytum* and occasionally in the *Bartonia* group.

*Leaves.*—The leaves are usually alternate, rarely subopposite and decussate as in *M. aborescens* and a few other members of the *Eumentzelia* section. The leaf shapes vary greatly, even on the same plant. The leaves are mostly sessile in the *Trachyphytum, Bicuspidaria,* and *Bartonia* sections, rarely petiolate, variously lobed, pinnatifid or entire.

The degree of pubescence varies on the two surfaces of the leaf; usually the pubescence is greater on the lower surface and veins. The young leaves are somewhat more pubescent than others. Petioles, if present, are usually short and pubescent, rarely glabrous.

*Pubescence.*—The peculiar hairs present in *Mentzelia* in many cases furnish an excellent basis for specific differentiation. The hairs are of three general types, namely, tapering spine-like hairs, Chinese pagoda-like hairs, which are broad at the base and referred to as glochidiate hairs, and those with tuberculate ‘‘stem’’ and harpoon top, or with a smooth stem and harpoon top. The usual form is the glochidiate type, of varying lengths, often appressed, especially on the leaves and stem.

Where abundant moisture is available the pubescence is scattered. In the more arid localities it is more copious and denser, with a reduction of leaf surface.

*Inflorescence.*—The inflorescence is terminal, cymose, one to many-flowered, often subtended by ovate deltoid lanceolate linear subulate bracts, which are simple, entire, or variously lobed or pinnatifid, and pubescent as on the leaves. The subtending bracts are usually green in color, though they may become membranous or scarious as in *M. involucrata* and *M. congesta*. The flowers are perfect, regular, and five-parted.

*Calyx.*—The calyx is five-parted, obtuse, ovate, acute, lanceolate, or long-acuminate, becoming subulate, frequently ciliate on the margins, with prominent veins of one to three. The inner surface is slightly villous, the outer surface variously pubescent, affording with other characters a basis for specific delimitation.

*Corolla.*—The color of the petals varies from almost white to greenish-yellow and deep orange. Occasionally a deeper color appears at the very base of the petal. A vermilion spot occurs at the base of the petal in *M. Lindleyi* and closely allied species. The petals may be connate, obovate, oblong-obovate, acute, or apiculate at the apex, rarely emarginate, narrowed at the base into a claw, and glabrous or pubescent.

*Stamens.*—The stamens present a valuable specific character. The filaments are linear or petaloid, the outer row often sterile, seldom antheriferous if assuming a petaloid form, bicuspidate at apex in the section *Bicuspidaria*. The stamens may be few, small, and all linear as in most of the *Trachyphytum* group, or numerous and either all linear or the outer row petaloid as in *Bartonia*.

*Hypanthium.*—The hypanthium is three-celled, opening by valves at the summit, rarely splitting longitudinally, with or without persistent calyx-lobes, pubescent in varying degrees, sessile or pedicellate.

*Fruit.*—The fruit of *Mentzelia* is a capsule with few to numerous seeds, with or without lamellae.

*Seeds.*—The seeds are winged, margined, or marginless. The shape and markings of the seeds have furnished constant dependable characters for separating species and a secondary sectional character.

## Generic Relationships

The genus *Mentzelia* is placed in the Mentzelioideae tribe of the Loasaceae, together with two other genera, namely, *Eucnide* and *Sympetaleia,* because of the number of stamens ranging from ten to indefinite and because of the absence of nectary-producing squamellae. *Mentzelia* is the only genus representing the subtribe Mentzelieae distinguished by the three parietal placentae and the ovules appearing in one or two series on each placenta. In the subtribe Eucnideae, which includes the two genera *Eucnide* and *Sympetaleia,* the ovules are in numerous series on each placenta.

The petals in the genus *Mentzelia* are free, whereas in *Eucnide* they are connate and in *Sympetaleia* they form an elongated tube with the filaments adnate to the tube. Stinging hairs are present in *Eucnide* and absent in *Mentzelia.* *Eucnide* and *Mentzelia* have two-celled anthers distinguishing them from *Sympetaleia,* which has one-celled anthers.

## Geographical Distribution and Phylogeny

The genus *Mentzelia* is a group of mesophytic and xerophytic plants having a distribution chiefly in western America. With the exception of *M. floridana* and *M. aspera* the genus extends from central United States to the Pacific coast, and from adjacent Canada south to Argentina, South America. *Mentzelia floridana* is found in Florida and the Bahama Islands and is closely related to *M. Lindheimeri* in Texas and Mexico. The species *M. aspera* has the most widespread distribution of the entire group, occurring in the subtropical regions of the West Indies and from southern Arizona southward to Argentina.

The species of the *Eumentzelia* section present a homogeneous group of more or less closely related forms. The plants comprising the *Eumentzelia* and *Bartonia* sections, on account of the frequently perennial habit and prevailingly undivided leaves, probably represent the more primitive characters of the genus and are thought to have originated from a suffruticose or arborescent ancestor which had its distribution in Mexico. The *Eumentzelia* section is mostly distributed in Mexico and Lower California southward into South America, with four species, *aspera, asperula, oligosperma,* and *floridana,* occurring within the boundaries of the United States. The *Bartonia* group is represented in South America by a single species which is also indigenous to Texas, Oklahoma, and Mexico. The group is generally distributed throughout the plains states, Rocky Mountains, and Pacific Coast regions.

The annuals constitute the two sections, *Trachyphytum* and *Bicuspidaria,* and represent the more advanced forms of *Mentzelia.* It is within these two groups that the greatest variation in leaf and flower structure is manifest. The *Bicuspidaria* section is represented in southern California, Arizona, Mexico, and Lower California. The species of the section *Trachyphytum* are distributed mostly in the Rocky Mountains and along the Pacific coast from British Columbia to Lower California. Four species of this section occur in South America.

There are apparently two centers of distribution, one in Mexico, and the other in the southwest portion of the United States in the region from New Mexico to southern California.

## TAXONOMY

**Mentzelia** [Plumier] Linn. Sp. Pl. ed. 1. 516. 1753; Gen. Pl. ed. 1. 338, n. 847. 1737, and ed. 5. 233, n. 595. 1754; Hort. Cliff. 492. 1737; Syst. ed. 10. 1076. 1759; Juss. Gen. Pl. 321. 1789; Lunan, Hort. Jam. **1**: 504. 1814; HBK. Nov. Gen. & Sp. **6**: 119. 1823; Kunth, Syn. Pl. **3**: 404. 1824; Torrey & Gray, Fl. N. Am. **1**: 532. 1840; DC. Prodr. **3**: 343. 1828; G. Don, Hist. Dichl. Pl.

**3**: 65. 1834; Endl. Gen. 390, No. 5111. 1840; Walp. Rep. Bot. Syst. **5**: 776. 1845-46; Brewer & Watson, Bot. Calif. **1**: 235. 1876; Baillon, Hist. Pl. **8**: 465. 1886; Greene, Fl. Francisc. 232. 1891; Greene, Man. Bot. Reg. San Francisco Bay, 141. 1894; Gilg in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{6a}$: 109. 1894, and ed. 2. **21**: 532. 1925; Chapman, Fl. Southeast. U. S. ed. 3. 107. 1897; Howell, Fl. N. W. Am. **1**: 239. 1897; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 22-23. 1900; Small, Fl. Southeast. U. S. 809. 1903; Rydb. Fl. Colo. 234-236. 1906; Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 436. 1906; Gray, Man. Bot. ed. 7. 588. 1908; Coulter & Nelson, Man. Bot. Rocky Mts. 324. 1909; Britton & Brown, Ill. Fl. ed. 2. **2**: 566. 1913; Piper & Beattie, Fl. Southeast. Wash. & Adj. Idaho, 166. 1914; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 436. 1915; Rydb. Fl. Rocky Mts. & Adj. Plains, 574. 1922; Davidson & Moxley, Fl. So. Calif. 239. 1923; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 361. 1925; Jepson, Man. Fl. Pl. Calif. 648. 1925; Fawcett & Rendle, Fl. Jam. **5**: 247. 1926; Rydb. Fl. Prairies & Plains Cent. N. Am. 558. 1932.

*Mentzelia* Plumier, Nov. Pl. Am. Gen. 40, *pl. 6.* 1703; Linn. Gen. Pl. ed. 1. 338, n. 847. 1737; Hort. Cliff. 492. 1737.

*Bartonia* Sims, in Bot. Mag. *pl. 1487.* 1812.

*Nuttallia* Raf. in Am. Month. 175. 1818.

*Torreya* Eaton, Man. Bot. ed. 5. 420-421. 1829, and ed. 6. 367. 1833.

*Acrolasia* Presl, Reliq. Haenk. **2**: 39. 1835.

*Creolobus* Lilja, Fl. öfver Sver. odl. Vext. 67. 1839.

*Microsperma* Hook. Ic. Pl. *pl. 234.* 1839.

*Chrysostoma* Lilja, Fl. öfver Sver. odl. Vext. Suppl. 1: 33. 1840; Linnaea **15**: 263. 1841.

*Touterea* Eaton & Wright, N. Am. Bot. 454. 1840.

*Trachyphytum* Nutt. ex Torrey & Gray. Fl. N. Am. **1**: 533. 1840.

*Hesperaster* Cockerell in Torreya **1**: 142. 1901.

*Bicuspidaria* Rydb. in Bull. Torr. Bot. Club **30**: 275. 1903.

Annual or perennial, rarely biennial herbs, shrubs, or rarely, trees, erect or trailing, freely branching, covered with various types of rigid tenacious barbed hairs, never stinging. Stems becoming white and shining in most species, scabrous or glabrous. Leaves alternate, rarely opposite, 3–5-lobed, coarsely toothed or pinnatifid, sessile to long-petiolate. Inflorescence terminal, cymose. Flowers 1 to many at apex of branches, sessile or shortly pedicellate, small or large, mostly white, yellowish, golden-yellow or orange, subtended by bracts. Calyx-tube cylindrical to ovoid or turbinate, sessile or pedicellate. Calyx-limb 5-lobed, imbricated, deciduous or persistent and withered in the mature fruit. Petals 5–10, imbricated, free or inconspicuously united at the base, obovate to obovate-oblong, rarely spathulate, narrowed or contracted at base, apiculate at apex, glabrous or pubescent on dorsal surface. Stamens numerous, 10–200, free from the petals but inserted with them on the throat of the calyx; filaments distinct, or in clusters opposite the petals, equal in length or the outer series longer, filiform or linear or the 10 exterior broadened, dilated to spathulate or petal-like, in 1 to 5 series, deciduous, always inflexed or incurved at the apex, rarely the 5 exterior ones sterile. Anthers introrse, bilocular, laterally dehiscent, attached at base or dorsal side. Style elongated, filiform, often twisted, smooth, angled, usually persistent in fruit, apex 3-cleft with usually 3 stigmatic surfaces, papillose. Disk concave, glabrous, or rarely pilose. Ovary unilocular, 2–80 ovules. Ovules anatropous, pendulous or horizontally placed, few to many in 1 or 2 rows on 3, rarely 5–7, filiform to linear, inconspicuous or prominent, smooth or incised, parietal placentae; funicle small or lacking. Fruit a short cylindical, oblong, or turbinate capsule, sessile or pedicellate, more or less densely ribbed at maturity, pericarp papery to somewhat woody, 3–7-valved or irregularly truncate at apex. Seeds in 1 or 2 series, flat or angled, with or without wings, testa papery or somewhat leathery, opaque or shiny, smooth, punctate or striate. Endosperm copious or scanty to almost lacking. Embryo erect or curved, radicle conic or nearly cylindrical, obtuse or somewhat acute, longer or shorter than the flattish cotyledons.

Type species: *Mentzelia aspera* Linn. Sp. Pl. 516. 1753.

### Key to the Sections

Filaments broadened, cuspidate at apex...............Section IV. Bicuspidaria
Filaments narrowed, not cuspidate at apex................
  Seeds horizontal....................................Section II. Bartonia
  Seeds pendulous.
    Placenta broad, plicated......................Section I. Eumentzelia
    Placenta narrowly filiform................Section III. Trachyphytum

## Section I. Eumentzelia Torrey & Gray

Section I. Eumentzelia Torrey & Gray, Fl. N. Am. 1: 533. 1840; Walpers, Rep. 2: 224. 1843; Brewer & Watson, Bot. Calif. 1: 235. 1876; Urban & Gilg in Engl. & Prantl, Nat. Pflanzenfam. $3^{6a}$: 110. 1894; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 41. 1900.

Mostly perennials; the stems, leaves, and capsules hirsute-scabrous with glochidiate and spine-like hairs; leaves sessile or petiolate, serrate-dentate to trilobed; flowers terminal or in the forks of the branches; petals 5, yellow to orange; filaments few to numerous, filiform or the outer 10 slightly broadened or petaloid, all antheriferous; capsule cylindrical to obconical-turbinate, sessile or pedicellate; placentae broad, irregularly plicate-rugose; seeds 1–15, rarely more, in 1 to 2 series, pendulous, striate to densely tuberculate-verrucose, opaque, usually not winged. Spp. 1–20.

### Key to Species of Section Eumentzelia

A. Leaves alternate.
  B. Calyx-tube and capsule cylindrical, mostly sessile.
    C. Outer stamens petaloid..................................*19. M. aspera*
    CC. Outer stamens not petaloid.
      D. Stamens 15 or more.
        E. Perennial; capsule thick-walled, often recurved, few-seeded ..........................................*13. M. oligosperma*
        EE. Annual; capsule thin-walled, straight, several-seeded...*18. M. asperula*
      DD. Stamens 10–12 ..................................*12. M. parvifolia*
  BB. Calyx-tube and capsule obconical or turbinate, attenuated below into more or less of a pedicel (except in *M. soratensis*).
    C. Stamens equal in size.
      D. Leaves mostly petiolate.
        E. Lower leaves petiolate, upper leaves subsessile.......*15. M. adhaerens*
        EE. Leaves all petiolate.
          F. Capsule sessile or nearly so; petals 7–9 mm. long......*17. M. texana*

FF. Capsule strongly pedicellate; petals 10–15 mm. long.
G. Stamens about 20; pedicel 3 mm. or more long. . . . *16. M. floridana*
GG. Stamens about 40; pedicel 1–1.5 mm. long. . . . *14. M. Lindheimeri*
H. Calyx-lobes lanceolate, 10–12 mm. long. . . . . . *10. M. chilensis*
HH. Calyx-lobes linear-lanceolate, 7 mm. long. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *10a. M. chilensis* var. *atacamensis*
DD. Leaves sessile.
CC. Stamens unequal in size.
D. Leaves sessile.
E. Leaves deeply incised to subtrilobate. . . . . . . . . . . . . . . . . . *7. M. strigosa*
EE. Leaves ovate to ovate-orbicular, never strongly incised.
F. Capsule sessile. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *11. M. sessilifolia*
FF. Capsule pedicellate.
G. Stamens 40–50, in 2 (rarely 3) series. . . . . . . . . . . . . . . . *9. M. ignea*
GG. Stamens 50–60, in 3 series.
H. Leaves ovate-lanceolate to triangular-lanceolate. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *5. M. soratensis*
HH. Leaves ovate . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *6. M. cordifolia*
DD. Leaves petiolate (upper leaves subsessile in sp. 8).
E. Petals 18–20 mm. long. . . . . . . . . . . . . . . . . . . . . . . . . . . *8. M. cordobensis*
EE. Petals 20–32 mm. long.
F. Petals 20–22 mm. long. . . . . . . . . . . . . . . . . . . . . . . . . *3. M. Fendleriana*
FF. Petals 23–32 mm. long.
G. Stamens 40–80, in 2–3 series. . . . . . . . . . . . . . . . . . . . . . *4. M. hispida*
GG. Stamens 100–120, in 4 series. . . . . . . . . . . . . . . . . . . . . . *2. M. scabra*
AA. Leaves opposite or subopposite. . . . . . . . . . . . . . . . . . . . . . . . . . *1. M. arborescens*

1. **M. arborescens** Urban & Gilg apud Urb. in Ber. Deut. Bot. Ges. **10**: 265. 1892; Gilg in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{6a}$: 110. 1894, and ed. 2. **21**: 534. 1925; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 76. 1900.

*M. Conzattii* Greenm. in Proc. Am. Acad. **32**: 298. 1897.

Tall shrub or small tree with brittle woody stems; stems yellowish, covered with a thin scarious bark, glabrous below, pubescent above on younger parts; lower leaves subopposite, upper more often distinctly alternate, simple, oblong-lanceolate, 4–12 cm. long, 1.5–3.5 cm. broad, acuminate, acute, finely dentate, gradually narrowed at the entire base into a short petiole, scabrous above, tomentose beneath, midrib somewhat depressed above, prominent beneath; petioles 4–12 mm. long; inflorescence cymose-paniculate; flowers pedicellate, showy, bright yellow, about 5 cm. in diameter; calyx-tube turbinate, barbellate-pubescent; calyx-lobes 5, lanceolate-ovate, acuminate, 12–15 mm. long, 4 mm. broad at base, pubescent; petals 5, rarely 6, ovate-oblong, short-acuminate, slightly narrowed at base, 2.5 cm. long, 1–1.5 cm. broad; stamens numerous, in 4 series, disposed in phalanges opposite the petals, the 4 outer filaments of each phalanx flattened and broadened over half their length, the remainder of the filaments filiform and about one-half or two-thirds as long as the outer ones; style single, filiform, somewhat attenuated and 6-angled at the summit; capsule broadly ovate, obtuse at base, yellowish-brown, distinctly striate, with persistent calyx-lobes and style, 3-valved at apex; seeds in 1 or 2 series on the placentae, placed horizontally in the centre of the capsule at maturity, winged.

Distribution: mountainous regions in southern Mexico.

Specimens examined:

MEXICO: Oaxaca, mountains near Tlacotalpan, 6000–8000 ft. alt., 7 Dec. 1894, *Nelson 2089* (US); Oaxaca de Juarez, 1550 m. alt., 19 Dec. 1906, *Conzatti* (ANSP, F, M, US, V); Oaxaca, 1550 m. alt., 10 March 1907, *Conzatti 1758* (US); Pueblo Nuevo, Miahuatlan, 2550 m. alt., 1920, *Conzatti 4094* (US); Juquila, Oaxaca, 1400 m. alt., 12 Dec. 1921, *Conzatti 4359* (US); Oaxaca, 1843, *Galeotti 3682* (K, V).

2. **M. scabra** HBK. Nov. Gen. et Sp. 6: 120. 1823; DC. Prodr. 3: 343. 1828; G. Don, Hist. Dichl. Pl. 3: 66. 1834; Dietrich, Syn. Pl. 3: 85. 1843; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 73. 1900.

Perennial, 4–8 dm. high; stems erect, dark yellow, scabrous with rigid verticillate glochidiate hairs; leaves alternate, ovate, regularly denticulate to crenate, acute, subrotund at the base, upper surface densely covered with short, recurved, tubercular-hispid hairs, dark green, the lower surface densely clothed with short verticillate glochidiate hairs, grayish, lower leaves short but distinctly petiolate, upper usually sessile; flowers sessile in the forks of dichotomous branches; calyx-tube obconical to turbinate, attenuated below, densely covered with long verticillate spine-like hairs; calyx-lobes ovate-oblong to ovate-lanceolate or lanceolate, 13–20 mm. long, persistent in fruit, irregularly reflexed, dark; petals 5, yellow, obovate to broadly obovate, 2–3 cm. long, shortly apiculate, narrowed at the base, dorsal surface with short hairs near the apex, otherwise glabrous; stamens 100–120, in 4 series, the 10 exterior nearly as long as the petals and broadened, rest filiform or narrowly linear and shorter, more or less coherent at the base; capsule subcylindrical, attenuated below into a pedicel 1.6–1.7 cm. long, grayish, scabrous; seeds 4–6, in 2, rarely 1, series, pendulous, irregularly ovate to ovate-oblong, brown or brownish-black, irregularly striated to densely verrucose-tuberculate, narrowly winged.

Distribution: in mountainous regions of Colombia, Ecuador, and Peru.

Specimens examined:

Colombia: Rio Guaitara, Pasto, 1500–1600 m. alt., *Lehmann 7944* (F, K); Rio Guaitara, between Luquerres and Pasto, 16 May 1876, *Andrè 3187* (F, K).

3. **M. Fendleriana** Urban & Gilg in Mem. Torr. Bot. Club 3: 34. 1893.

Perennial; stems erect, white or yellowish-white, scabrous; leaves alternate, lanceolate, regularly dentate or serrate, base subcuneate, apex shortly acuminate; petiole 1.3 cm. long, scabrous, canescent; flowers sessile, disposed in cymes at ends of the branches; calyx-tube obconical or turbinate, attenuated, hirsute; calyx-lobes ovate-lanceolate, 13–14 mm. long, acuminate, pilose, persistent, withered, black, reflexed on the fruit; petals 5, yellow, obovate or obovate-oblong, 2–2.2 cm. long, apiculate, apex pilose; stamens 70–80, in 4 series, the 10 exterior filaments 1.8 cm. long, linear, the inner series filiform and shorter; style filiform, persistent in fruit; capsule obconical or turbinate, attenuated, black, scabrous, shortly pedicellate, pedicel about 1 cm. long; seeds 5–6, pendulous, irregularly ovate-oblong, yellow or grayish-yellow, striate, verrucose-tuberculate.

Distribution: from Venezuela southward along the western coast of South America from Ecuador to Chile.

Specimens examined:

Venezuela: near Tovar, 1854–5, *Fendler 1876* (ANSP, M).

Ecuador: near Pillaro, Prov. Tungurahua, without date, *Pachano 79* (US).

Peru: without definite date or locality, *Wilkes' Exploring Expedition* (US); Huanantango, without date, *Bordeau* (K); Lima, without date, *Cuming 1011* (K); Ollantaytambo, 3000 m. alt., 24 April 1915, *Cook & Gilbert 280* (US); same locality, 4 May 1915, *Cook & Gilbert 545* (US); Uspachaca, 8500 ft. alt., 23 June 1922, *Macbride & Featherstone 1296* (US); Tulara, Prov. Paita, 1925, *Haught* (US); near Urubamba, 3000 m. alt., April 1926, *Herrera 1066* (US); Urubamba Valley, Gucay, 3000 m. alt., Jan. 1927, *Herrera 1366* (US); same locality, July 1927, *Herrera 1529* (US).

BOLIVIA: Bolivian Plateau, 1891, *Bang 748* (ANSP, K, M, US); same locality, *Bang 1082* (ANSP, F, M, US); Parotani, 20 March 1892, *Kuntze* (F); Valley of Chillo, 1500 ft. alt., without date, *Hall 11* (K); Andacollo Valley near Coquimbo, 1000 ft. alt., Sept. 1927, *Elliott 31* (K).

4. **M. hispida** Willd. Sp. Pl. $2^2$: 1176. 1799; Juss. Ann. Mus. Nat. Hist. 5: 24. 1804; DC. Prodr. 3: 343. 1828; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 64. 1900.

*M. aspera* Lam. Ill. *pl. 425.* 1797; Cav. Ic. 1: 51, *pl. 70.* 1791.

*M. stipitata* Mociño & Sesse, Fl. Mex. ex DC. Prodr. 3: 343. 1828; Presl, Reliq. Haenk. 2: 40. 1835.

*M. gracilis* Urb. & Gilg, *l.c.* 61. 1900.

*M. Palmeriana* Urb. & Gilg, *l.c.* 75.

*M. Karwinskii* Urb. & Gilg, *l.c.* 65.

*M. imbricata* Urb. & Gilg, *l.c.* 67.

*M. polyantha* Urb. & Gilg, *l.c.* 70.

*M. Orizabae* Urb. & Gilg, *l.c.* 60.

*M. Galeottii* Urb. & Gilg, *l.c.* 69.

*M. incisa* Urb. & Gilg, *l.c.* 59.

Annual or perennial from a fusiform root, 5–8 dm. high, striate, brown or brownish-yellow, densely scabrous, especially on younger branches; stems dichotomously branched; leaves alternate, ovate-lanceolate, broadly serrate-dentate to subtrilobate, acuminate at the apex, rotund at the base, rarely subcordate to subcuneate, shortly petiolate, 4–6 cm. long, upper and lower surfaces densely scabrous; flowers at the apex of branches or in the forks of dichotomous branches, orange-yellow; calyx-tube conical, attenuated, hirsute-scabrous; calyx-lobes ovate-lanceolate to lanceolate, long-acuminate, 12–15 mm. long, persistent, withered in fruit, reflexed, brownish-gray; petals 5, obovate or obovate-oblong, abruptly apiculate, 2–3 cm. long, slightly puberulent at the apex, otherwise glabrous; filaments 40–60, in 2–3 series, the exterior 10 filaments longer, linear, inner series filiform and somewhat shorter; style filiform, glabrous, angled, papillose at the apex, withered and persistent in fruit; capsule conical, attenuated, brown or brownish-black, scabrous, subchartaceous; seeds 6–10, pendulous, irregularly ovate to ovate-oblong, brownish-gray, irregularly striate to densely tuberculate-verrucose.

Distribution: Mexico.

Specimens examined:

Mexico: indefinite locality, without date, *Wawra 304* (V); *Uhde 1073* (US); Valley of Mexico, *Schenitz* (V); Valley of Mexico, *Schaffner 160* or *169* (K); indefinite locality, without date, *Orcutt 4420* (K); Chapultepec, *Knechtel 757* (V); Pahuan, *Ehrenberg 202* (US); Orizaba, State of Vera Cruz, *Botteri 558* (US); same locality, *Botteri 769* (K); without definite locality, 1839, *Berlandier 654* (M, V); Aguas Calientes, Zacatecas, 1839, *Hartweg 16* (K, V); Oaxaca, Nov.–April 1840, *Galeotti 3683* (V); Tehuacan, Oaxaca, 5000 ft. alt., Aug. 1840, *Galeotti 3681* (V); Oaxaca, 1842, *Liebmann 94* (US); Toluca, 1846, *Heller* (V); Montevideo, 1852, *Hooker* (K); Orizaba, 1853, *Müller 1088* (V); Valley of Mexico, Mt. Zacoalco, 5 July–12 Aug. 1865, *Bourgeau 295* (K, M); Cakoboya, 12 Aug. 1867, *Bilimek 270* (US); indefinite locality, 1868, *Hahn 29* (M); San Luis Potosi, 1876, *Schaffner 110* (US); region of San Luis Potosi, 6000–8000 ft. alt., 1878, *Parry & Palmer 257* (ANSP, M, US); Soledad, 25 miles southwest from Monclova, Coahuila, 9–19 Sept. 1880, *Palmer 353* (ANSP, US); Caracol Mts., 1880, *Palmer 357* (US); Saltillo, 1898, *Palmer 352* (ANSP, C, M, US); Santa Eulalia Mts., Chihuahua, 19 Sept. 1885, *Pringle 616* (ANSP, F, US); Rio Blanco, State of Jalisco, June–Oct. 1886, *Palmer 600* (ANSP, US); near Dominguillo, 4500–5500 ft. alt., 30 Oct. 1894, *Nelson 1837* (US); same locality, 3 Oct. 1894, *Nelson 1592* (US); Durango, April–Nov. 1896, *Palmer 485* (F, M, US); Puebla, 1900, *Nicolas & Arsène 35* (F); near Tehuacan, State of Puebla, 1–2 Aug. 1901, *Rose & Hay 5876* (US); hills near El Salto, Hidalgo, 7500 ft. alt., 15 Sept. 1902, *Pringle 9802* (F, M, US); near Aguas Calientes, 9 Oct. 1903, *Rose & Painter 7734* (US); near El Salto, Hidalgo, 16 Sept. 1903, *Rose & Painter 7071* (US); Ixmiquilpan, Hidalgo, Aug. 1905, *Purpus* (C); between San Pablo and Cuderozta, State of Queretaro, 25 Aug. 1905, *Rose, Painter & Rose 9831* (US); near Tlalpam, Valley of Mexico, 1905, *Rose, Painter & Rose 9444* (US); near San Juan del Rio, State of Queretaro, 18 Aug. 1905, *Rose, Painter & Rose 9595* (US); Del Cierro a In. Juan, State of Queretaro, 27 Aug. 1905, *Altamirano* (US); Cerro San Antonio, Oaxaca, 1700 m. alt., 28 Oct. 1906, *Conzatti 1590* (US); same locality, 1600 m. alt., 12 Oct. 1907, *Conzatti 2035* (F); Morelia, 2000 m. alt., 6 Sept. 1909, *Arsène 47* (F); Churubusco, 4 Oct. 1910, *Orcutt 4296* (F, M); Tlalpam, 16 Aug. 1910, *Orcutt 3622* (F, K, M, US); Minas de San Rafael, San Luis Potosi, Nov. 1910, *Purpus 4892* (C); Puebla, 1910, *Arsène 35* (F); Cerro San Miguel, near Morelia, State of Michoacan, 15 Sept. 1910, *Arsène 5203* (US); near Morelia, State of Michoacan, 1910, *Arsène 5338* (K, M, US); Rincon, near Morelia, State of Michoacan, 1900 m. alt., 8 Sept. 1910, *Arsène 5288* (M, US); Acueducto Hercules, Queretaro, 1912, *Arsène 10609* (US); Buena Vista, State of Tamaulipas, 18 June 1919, *Wooton* (US); Tamps, 9000 m. alt., 8 April 1926, *Runyon 997* (US).

**5. M. soratensis** Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 68. 1900.

Perennial; stems erect, brown, terete, striated, scabrous, branching above; leaves alternate, sessile, ovate-lanceolate to triangular-lanceolate, 3–3.5 cm. long, dentate or serrate, scabrous, base rotund, apex short-acuminate; flowers sessile, disposed in cymes at the ends of branches; calyx-tube obconical or turbinate, attenuated but not pedicellate, 4–5 mm. long; calyx-lobes ovate, acuminate, 10–12 mm. long, persistent, withered, black; petals 5, obovate to obovate-oblong, 1.8–2 cm. long, apex pilose, apiculate; stamens 50–60, in about 3 series, the 10 exterior filaments 1.5–1.7 cm. long, linear, the inner series filiform, less than 1 cm. in length; capsule obconical or turbinate, black, scabrous, 1.3–1.5 cm. long, attenuated toward the base into a very short pedicel; seeds 4–6, pendulous, irregularly ovate to ovate-oblong, gray or grayish-yellow, irregularly striate to tuberculate-verrucose.

Distribution: Ecuador, Peru and Bolivia.

Specimens examined:

Ecuador: vicinity of Huigra, 18 Aug. 1918, *Rose & Rose 22198* (US); Huigra, Prov. Chimborazo, 3 Aug. 1920, *Holway & Holway 819* (US); same locality, 1200 m. alt., 4–27 July 1923, *Hitchcock 40317* (US).

Peru: rocky cliffs, Tiabaya, Dept. Arequipa, 2000 m. alt., 1925, *Pennell 13069* (ANSP).

Bolivia: Prov. Larecaja, 2650 m. alt., May–Dec. 1857, *Mandon 621* (V); Sorata, 17 April 1920, *Holway & Holway 540* (US).

**6. M. cordifolia** Dombey ex Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 74. 1900.

Perennial branched spreading shrub with erect brown or yellowish-brown stems, densely covered with verticillate glochidiate and a few spine-like hairs, branches ascending; leaves alternate, sessile, ovate, 3–6 cm. long, dentate to serrate, incised below the middle, acute at the apex, subcordate at the base, upper surface roughened with long barbed spine-like hairs, lower surface densely covered with verticillate glochidiate hairs, scabrous; flowers in forks of branches, orange, closed during the day; calyx-tube cylindrical or subconical, attenuated below into a short pedicel, densely clothed with long antrorse spine-like and verticillate glochidiate hairs; calyx-lobes ovate, lanceolate, long-acuminate, 10 mm. long, persistent on the fruit, dark, irregularly reflexed; petals 5, yellow, obovate, 1–2 cm. long, narrowed at base, apex short-acuminate; stamens about 60, in 3 series, the 10 exterior linear and 1 cm. long, the rest filiform and shorter; capsule subcylindrical, attenuated at base with pedicel 8 mm. long, grayish, scabrous; seeds 4–5, in 1 or 2 series, pendulous.

Distribution: open rocky slopes, on shale and gravel, in Peru and Bolivia.

Specimens examined:

PERU: without definite locality or date of collection, *McLean* (K); dry plains, Anco, (probably *Matthews*) *596* (K); loose soils of steep southern slope, Matucana, 8000 ft. alt., 12 April–3 May 1922, *Macbride & Featherstone 130* (US); stony slopes, shale, and gravel, Huanuco, about 7000 ft. alt., 5–8 April 1923, *Macbride 3215* (US); open rocky slopes, along Rio Chillon, near Viscas, Dept. Lima, 1800–2000 m. alt., 10–15 June 1925, *Pennell 14472* (ANSP, US); open rocky slopes, San Buenaventura, Dept. Lima, 2700–2800 m. alt., 17 June 1925, *Pennell 14568* (ANSP).

7. **M. strigosa** HBK. Nov. Gen. & Sp. **6**: 120. 1823; DC. Prodr. **3**: 343. 1828; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 55. 1900.

Perennial; stems erect, brown or brownish-gray, terete, striated, scabrous; leaves alternate, sessile, ovate-triangular, 3 cm. long, shortly acuminate, serrate, deeply incised and partially 3-lobed, rotund to subcordate at the base, scabrous, subcanescent on both surfaces; flowers disposed in cymose clusters at the apex of branches; calyx-tube obconical to turbinate, attenuate, 5–6 mm. long, hirsute; calyx-lobes lanceolate to linear-lanceolate, 10–12 mm. long, long-acuminate, pilose, persistent, reflexed in fruit; petals 5, yellow, obovate or obovate-oblong, narrowed toward the base, long-apiculate or acuminate, 2–2.5 cm. long, apex pilose; stamens about 50, in 2 or 3 series, the exterior 10 filaments about 1.6 cm. long, broadened, others filiform and shorter; style filiform, glabrous, angled, persistent in fruit; capsule obconical, attenuated, 1–1.5 cm. long, sessile, brownish-black; seeds 8–10, pendulous, irregularly ovate to ovate-oblong, brownish-yellow, striate, more or less tuberculate-verrucose, not winged.

Distribution: reported from Mexico. Though no authentic material has been available for critical study, *M. strigosa* is apparently a distinct Mexican species and has been retained as such by the writer. It is closely related to *M. soratensis* of South America and to *M. hispida* of Mexico.

8. **M. cordobensis** Urban & Gilg in Rev. Mus. de La Plata 5: 289. 1893; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 63. 1900.

*M. chilensis* Griseb. Abh. Ges. Göttingen [Pl. Lorentz.] **19**: 102. 1874.

Perennial; stems erect, 8–10 dm. high, brownish or yellowish-brown, scabrous; leaves alternate, lanceolate to ovate-lanceolate, 7 cm. long, dentate or serrate, scabrous, subcanescent, apex shortly acuminate, base round; lower leaves petiolate, the petioles 4–5 mm. long, upper subsessile; flowers in cymes at apex of branches; calyx-tube obconic to turbinate, attenuated below, 6 mm. long, scabrous; calyx-lobes lanceolate-acuminate, pilose, black, persistent, withered, reflexed in fruit; petals 5, orange, obovate to obovate-ovate, narrowed toward the base, long-acuminate, 1.8–2 cm. long, pilose; stamens 50, in 3 series, the 10 exterior filaments 1.5 cm. long, linear, the inner series filiform and shorter; style filiform, persistent on the fruit; capsule obconical or turbinate; black, scabrous, 1.3–1.5 cm. long, attenuated into a short pedicel; seeds 4–6, pendulous, irregularly ovate to ovate-oblong, brown or brownish-black, irregularly striated, tuberculate-verrucose.

Distribution: in the Province of Cordoba, Argentina.

Specimens examined:

ARGENTINA: Province of Cordoba, without date, *Lossen 163* (ANSP, F, M); Cordoba, Dec. 1891, *Kuntze* (F).

9. **M. ignea** (Phil.) Urban & Gilg in Engl. & Prantl, Nat. Pflanzenfam. $3^{6a}$: 110. 1894; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 58. 1900.

*Loasa ignea* Phil. Anal. Mus. Nat. Chile, Bot. **1891**: 24. 1891.

Perennial; stems erect, branched above, yellow or yellowish-white, terete, striate, scabrous; leaves alternate, sessile, broadly ovate, 3.5–3.8 cm. long, scabrous, subcanescent, dentate or serrate, incised, base cordate-semiamplexicaul; flowers sessile at the apex of branches; calyx-tube subturbinate or subcylindrical, 5 mm. long, attenuated into a short pedicel, hirsute; calyx-lobes ovate, acuminate, pilose, persistent, withered, yellow, reflexed in fruit; petals 5, orange, obovate, long-apiculate, 1.5–2 cm. long, apex pilose; stamens 40–50, in 2 or 3 series, the 10 exterior filaments longer and more broadened than the inner filiform series; style filiform, persistent, withered in fruit; capsule subturbinate to subcylindrical, black, 1–1.3 cm. long, attenuated into a pedicel; seeds 5–6, pendulous, irregularly ovate to ovate-oblong, brownish-gray or grayish-yellow, irregularly striate to tuberculate-verrucose, not winged.

Distribution: in Chile and Peru.

Specimens examined:

PERU: Arequipa Desert, 21 Aug. 1925, *Cockerell* (US).

**10. M. chilensis** Gay, Fl. Chile 2: 431. 1846.

Perennial with stems more or less erect, brown or brownish-yellow, striate, scabrous; leaves alternate, sessile, broadly ovate, 2–3.5 cm. long, dentate or crenate, obtuse at the apex, rotund at the base, rarely subamplexicaul-cordate, scabrous on both surfaces, canescent; flowers sessile, in clusters of 1–3 at ends of branches; calyx-tube obconical or turbinate, 12–18 mm. long, attenuated into a pedicel, scabrous; calyx-lobes lanceolate, 10–12 mm. long, long-acuminate, pilose, persistent, withered, blackish, and reflexed on the fruit; petals 5, orange-yellow, obovate, shortly apiculate, 1–1.5 cm. long, apex pilose; stamens 40–50, in 2 or 3 series, filaments linear or filiform, 1 cm. long; style filiform, 1 cm. long, glabrous, angled, persistent on the fruit; capsule obconical or turbinate, base attenuated, pedicellate, black, scabrous, 9 mm. long; seeds 6–8, pendulous, irregularly obovate to ovate-oblong, brown or brownish black, irregularly striate to tuberculate-verrucose, not winged.

Distribution: in Chile and Argentina.

Specimens examined:

ARGENTINA: Puntilla de Villavil, Prov. Catamarca, Feb. 1876, *Schickendantz 250* (M photograph).

**10a. M. chilensis** Gay var. **atacamensis** Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 50. 1900.

*M. chilensis* Phil. Fl. Atac. 19, No. 109. 1860.

Calyx-lobes linear-lanceolate, about 7 mm. long, acuminate; calyx-tube subcylindrical-oblong, attenuated into a pedicel 2–3 mm. long.

Distribution: Atacama Desert, Chile.

Specimens examined:

CHILE: Atacama Desert, without date, *Philippi* (M photograph, V); Prov. Antofagusta, Taltal, 50 m. alt., Oct. 1925, *Werdemann 798* (F, M, US).

**11. M. sessilifolia** Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 57. 1900.

Perennial; stems erect, yellow, striate, scabrous; leaves alternate, sessile, broadly ovate to ovate-orbicular, 3.5 cm. long, denticulate or crenate, acute or obtuse at the apex, subcordate at the base, scabrous, and subcanescent; flowers disposed in cymes at ends of branches; calyx-tube obconical to turbinate, attenuated, 7–8 mm. long, scabrous; calyx-lobes lanceolate, long-acuminate, pilose, persistent, withered, reflexed and black; petals 5, yellow, obovate to obovate-lanceolate, narrowed at the base, apiculate and pilose at the apex, 22–25 mm. long; stamens about 40, in 2 or 3 series, the 10 exterior filaments 1.6 cm. long and somewhat broadened, inner series shorter and filiform; style 1.7 cm. long, persistent and withered on the fruit; capsule obconical to narrowly turbinate, attenuated, sessile, 1.4–1.5 cm. long, black, scabrous; seeds 5–7, pendulous, irregularly ovate to ovate-oblong, gray or grayish-yellow, irregularly striate, densely tuberculate-verrucose, not winged.

Distribution: Mexico.

Specimens examined:

MEXICO: Minas de San Rafael, San Luis Potosi, Nov. 1910, *Purpus 4930* (C); Dist. Etla, Oaxaca, 25 Sept. 1920, *Conzatti 4051* (US).

**12. M. parvifolia** Urban & Gilg in Rev. Mus. de la Plata 5: 289. 1893; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 45. 1900.

*M. chilensis* Griseb. Symb. Argent. 138. 1879. (not *M. chilensis* Gay).

*M. Grisebachii* Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 48. 1900.

Biennial or perennial herbaceous plants; stems few to several, branching freely, sprawling or spreading, white or yellowish, covered with short verticillate glochidiate hairs; leaves alternate, sessile or nearly so, ovate, 2–4 cm. long, often smaller, dentate to sinuate-dentate, frequently deeply lobed, acute at the apex, cuneate at the base and narrowed into a very short petiole, scabrous to subcanescent, lower surface covered with verticillate glochidiate hairs, upper surface clothed with antrorse spine-like hairs; flowers in forks of the branches, sessile; calyx-tube cylindrical, 5 mm. long, not attenuated below, densely covered with verticillate glochidiate hairs; calyx-lobes ovate-lanceolate, acute or shortly acuminate, 3–4 mm. long, deciduous; petals yellow or orange, obovate-oblong to oblong, 5–7 mm. long, narrowed at base, densely pilose on the dorsal surface near the apex; filaments 10–12, in 1 series, 4–5 mm. long, filiform, linear; capsule cylindrical, sessile, not attenuated at base, obtuse, 7–12 mm. long, brown or brownish-black, always somewhat recurved, striated, crowned with persistent style; seeds 1–4, pendulous, oblique to irregularly rectangular, tuberculate, undulate-striate, brown to brownish-gray, not winged.

Distribution: Bolivia and Argentina.

Specimens examined:

BOLIVIA: Bolivian plateau, collection of 1891, *Bang 1005* (ANSP, K, M, US).

ARGENTINA: LaPlaza, Dept. Andalaga, Prov. Catamarca, 2400 m. alt., 9–10 Feb. 1916, *Jörgensen 1600* (C, M, US); Cordoba, Dec. 1891, *Kuntze* (F).

13. **M. oligosperma** Nutt. in Sims, Bot. Mag. **42**: *pl. 1760*. 1815; DC. Prodr. **3**: 343. 1828; G. Don, Hist. Dichl. Pl. **3**: 65. 1834; Torrey & Gray, Fl. N. Am. **1**: 533. 1840; Dietrich, Syn. Pl. **3**: 84. 1843; Gray in Mem. Am. Acad. [Pl. Fendl.] **4**: 47. 1849; Gray in Boston Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 191. 1850; Urban in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 47. 1900; Small, Fl. Southeast. U. S. 809. 1903; Gray, Man. Bot. ed. 7. 588. 1908; Coulter & Nelson, Man. Bot. Rocky Mts. 324. 1909; Rydb. Fl. Rocky Mts. & Adj. Plains, ed. 2. 574. 1922.

*M. aurea* Nutt. Gen. **1**: 300. 1818.

*M. rhombifolia* Nutt. ex Torrey & Gray, Fl. N. Am. **1**: 533. 1840.

*M. petiolata* Buckley in Proc. Acad. Sci. Phila. **13**: 455. 1861.

*M. Nelsonii* Greene in Erythea **3**: 70. 1895.

*M. Diehlii* Jones, Contr. West. Bot. **12**: 16. 1908.

*M. monosperma* Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **16**: 149. 1913.

Perennial herbaceous plants, rough with multi-barbate hairs; stems erect, dichotomously branched, brittle, white or yellowish, cortex becoming loose and papery; leaves alternate, ovate to ovate-lanceolate, 3–7 cm. long, 2–3 cm. broad, sessile, rarely subsessile, irregularly toothed or incised, somewhat lobed and angled, apex acute, base narrowed to cuneate, both surfaces of leaf armed with barbed glochidiate and antrorse spine-like hairs; flowers toward the apex of branches, in 1–3-flowered cymes; calyx-tube narrowly cylindrical, not attenuated, sessile, 5–6 mm. long, terete, densely covered with verticillate glochidiate hairs; calyx-lobes lanceolate, linear, long-acuminate, 7–9 mm. long, covered with glochidiate hairs, deciduous in mature fruit; petals 5, cuneate-oblong, 8–10 mm. long, cuspidate, entire, somewhat shorter than the stamens, dorsal surface densely covered with short hairs at the apex, otherwise glabrous; stamens about 25, in 2 series, all nearly equal, 7–9 mm. long, filaments linear, filiform; capsule cylindrical, 1–1.5 cm. long, yellowish-green or yellow, scabrous, coriaceous or woody, nearly always curved, striate, sessile; seeds 1–4, pendulous, obovate to obliquely rectangular, irregularly tuberculate, undulate-striate, brown or mottled grayish-brown, not winged.

Distribution: on dry, exposed, gravelly or sandy places, from Texas to Arkansas and west to Wyoming and New Mexico. (One specimen collected by Dr. Leavenworth in "eastern Florida.")

Specimens examined:

FLORIDA: "eastern Florida," *Dr. Leavenworth* (ANSP, M).

MISSOURI: rocky glades, Jackson Co., 4 Aug. 1864, *Broadhead* (M); rocky bluffs, Sept. 1869, *E. Hall* (F); Allenton, 27 Aug. 1878, *Letterman* (US); St.

Louis Co., 25 June 1879, *Letterman* (F); rocky hills near St. Louis on Meramec River, 27 June 1879, *Eggert* (C, M, US); Allenton, 20 June 1880, *Letterman* (D, F, M); Allenton, June 1882, *Letterman* (F, US); Allenton, 18 July 1883, *Kellogg* (M); Dodson, 26 Aug. 1885, *Bush 238* (M); St. Paul, St. Louis Co., 25 June 1886, *Wislizenus 505* (M); rocky hills north of Glencoe, Sept. 1887, *Eggert* (M); Green Co., 22 June 1888, *Blankinship* (US); Glencoe, 25 Sept. 1890, *Glatfelter* (M); southwest Missouri, 1890, *E. Hall* (F); rocky hills near St. Louis, 21 May 1896, *Eggert* (M); limestone cliffs, near Glencoe, May 1897, *Russell* (M); Gasconade, below Big Piney River, 12 Aug. 1897, *Trelease 348* (M); crevices of rock, Dodson, 10 July 1898, *Mackenzie 233* (F, RM); barrens, Noel, 9 Aug. 1908, *E. J. Palmer* (M); barrens, Noel, 9 Aug. 1908, *Bush 5034* (M); exposed limestone bluffs on Grove Creek, Jasper Co., 22 June 1909, *E. J. Palmer 2356* (M); dry cliffs, Scotland, 27 June 1909, *E. J. Palmer 2356* (M); barrens, Purcell, 11 Aug. 1907, *E. J. Palmer 1099* (M); on mine dumps near Mo. Pac. depot, Carthage, 17 July 1910, *E. J. Palmer 3004* (M); limestone ledges, vicinity of Gates, Greene Co., 26 Aug. 1912, *Standley 9400* (US); Jerome, 10 July 1912, *Kellogg* (M); dry limestone ledges, Careyton, Jasper Co., 8 June 1913, *E. J. Palmer 3986* (M); by railroad, near Glencoe, 13 July 1918, *Greenman 3836* (M).

ARKANSAS: White River near Eureka, 18 July 1898, *Glatfelter* (M); dry rocky hillsides, Norfolk, Baxter Co., 20 June 1914, *E. J. Palmer 6043* (M); exposed limestone ledges, Beaver, Carroll Co., 22 June 1914, *E. J. Palmer 6327* (M).

SOUTH DAKOTA: Hot Springs, without date, *MacElwee* (ANSP); Elk Creek Canyon, Black Hills, 14 Aug. 1908, *Visher* (F); Rapid City, 6 Aug. 1908, *Visher 1293* (F); dry clay bank, Erskine, Hot Springs, 22 July 1924, *McIntosh 504* (RM); East Park Gate, Grace Coolidge Creek, Black Hills, 24 July 1929, *Lee* (RM).

KANSAS: Junction City, without date, *Moyer* (US); Lawrence, Sept., without date, *Stevens* (US); Pawnee Rock, western prairies, Sept. 1848, *Gordon* (M); Miami Co., Aug. 1883, *Oyster* (M); Manhattan, Riley Co., 7 July 1884, *Kellerman* (US); prairies and naked clay bluffs, Caldwell, 10 Sept. 1890, *Smyth 272* (US); Manhattan, 30 Aug. 1892, *Norton* (M, US); Phillipsburg, 5 Aug. 1892, *Harshbarger* (F); Manhattan, Sept. 1893, *Norton* (M); gravelly places, near Osborne City, 2 June 1894, *Shear 67* (US); stony hills, Riley Co., 29 June 1895, *Norton 174* (M, RM, US); Riley Co., July 1897, *Pond* (P); Cowley Co., July 1898, *White* (M); limestone hillsides, 12 miles north of Scott City, 16 July 1929, *Rydberg & Imler 1086* (M).

OKLAHOMA: without locality, 8 July 1872, *Hall* (US); Limestone Gap, 20 July 1877, *Butler* (F, M); without locality, June 1877, *Butler 14* (M); Limestone Gap, 1877, *Butler 57* (M); Caddo, 20 June 1891, *Sheldon 231* (US); Cherokee Outlet, 8 June 1891, *Carleton 216* (US); near Tucker, July 1893, *Brown* (ANSP); Woods Co., 29 June 1900, *White* (RM); Mountain Park, 17 July 1903, *Duncan 57* (M); dry calcareous banks, Marietta, Love Co., 10 July 1916, *E. J. Palmer 10417* (D, M); Davis, 19 June 1916, *Emig 610* (M); vicinity of Fort Sill, 22 June 1916, *Mrs. J. Clemens 11694* (M); Fort Sill, 1 June 1916, *Mrs. J. Clemens 11694* (RM); Arbuckle Mts., near Davis, 23 June 1917, *Emig 828* (M); sandy rocky soil on river bank, 1 mile northwest of Ripley, Payne Co., 25 July 1927, *Stratton 232* (M); rocky clay soil, 3 miles south of Hitchcock, Blaine Co., 26 Aug. 1927, *Stratton 476* (M).

TEXAS: without definite locality, *Drummond 49* (V); Bexar Co., without date, *Jermy* (M); Gill Co., without date, *Jermy* (US); Enchanted Rock, Gillespie Co., without date, *Jermy 164* (M, US); Shackelford Co., without date, *Holstein* (ANSP); without definite locality, collection of 1835, *Drummond 90* (*300*) (V); 15 July 1845, *Fremont's Expedition 123* (M); Guadalupe, July–Aug. 1846, *Lindheimer 396* (ANSP, C, M, US, V); Cibola, near Guadalupe, May 1846, *Lindheimer 143* (M); Comanche Spring, near New Braunfels, June 1849, *Lindheimer 816* (F, M, US); Mexican Boundary Survey, northwestern Texas, 1852, *Parry* (M); Fort Smith to the Rio Grande, 31 Aug. 1853, *Bigelow* (US); dry uplands, Dallas, June 1879, *Reverchon 323* (M, US); Navarro Co., 22 May 1880, *Joor* (M); Linn Co., Aug. 1883, *Oyster 2800* (CAS); without locality, 1887, *Nealley* (US); Colorado, 8 June 1890, *Eggert* (M); without locality, 1890, *Nealley* (US); without locality, 1892, *Nealley 122* (US); Dallas, 15 June 1898, *Glatfelter* (M); Turtle Creek, Kerr Co., 2 May 1899, *Bray 223* (US); stony hills, West Dallas, 23 June 1899, *Eggert* (M); common on hills, Dallas, 29 Sept. 1900, *Bush 1178* (M); Canyon, 13 Aug. 1900, *Eggert* (M); San Antonio, common in barrens, 20 Sept. 1901, *Bush 859* (M); Weatherford, 30 May 1902, *Tracy 8047* (F, M, US, V); Bexar Co., 1903, *Jermy* (M); on limestone hills near Bracken, Bexar Co., 29 June 1903, *Groth 21* (F, US); Coombs Branch, 25 July 1903, *Reverchon 323* (M); Waco, 16 Sept. 1905, *Pace 30* (M); Leon Springs, Bexar Co., 29 May 1911, *Clemens & Clemens 542* (M, P); San Antonio, Bexar Co., 20 June 1911, *Clemens & Clemens 541* (P, RM); dry ground, Chisos Mts., 14 Aug. 1915, *Young* (M); dry limestone bluffs, San Saba Co., 4 May 1917, *E. J. Palmer 11800* (M); sandy uplands, open woods, Clyde, Callahan Co., 26 May 1918, *E. J. Palmer 13697* (M); dry rocky banks of canyon, Gamble's Ranch, Armstrong Co., 6 June 1918, *E. J. Palmer 13988* (M); dry exposed ledges, limestone bluffs, Strawn, Palo Pinto Co., 26 June 1918, *E. J. Palmer 14249* (M); flats along ocean, North Beach, Corpus Christi, Nueces Co., 7 Aug. 1921, *Ferris & Duncan 3229* (CAS, D, M); Dunham's Island, 6 Sept. 1922, *Tharp 1580* (US); Pumpville, 1500 ft. alt., 19 July 1922, *Fisher 295* (US); rocky ground along Limpia Creek, near Ft. Davis, Jeff Davis Co., 17 June 1926, *E. J. Palmer 31003* (M); rocky hillsides, Goliad, April 1927, *Williams 83* (ANSP); north of Del Rio, 17 April 1930, *Jones 25661* (M).

COLORADO: Cañon City, 1872, *T. S. Brandegee B377* (C, M); Cañon City, 1873, *T. S. Brandegee* (ANSP); Cañon City, June 1877, *T. S. Brandegee* (F); foothills, Larimer Co., 6000 ft. alt., 20 July 1895, *Cowen* (C, M, RM); near foothills, west of Loveland, 23 Aug. 1905, *Osterhout 3154* (RM).

**14. M. Lindheimeri** Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 54-55. 1900.

Annual, 5–6 dm. high; stems solitary, dichotomously branched toward apex, erect, striated, yellow or yellowish-white, densely scabrous; leaves alternate, bright green, ovate, 6–7 cm. long, dentate or crenate to more or less deeply incised to 3-lobed—the middle lobe large, acute or shortly acuminate at the apex—upper surface and margins scabrous with spine-like hairs, lower surface clothed with glochidiate hairs; flowers at apex of branches or borne in forks of dichotomous branches, yellow to orange; calyx-tube conical, attenuated below into the pedicel, often slightly reflexed, hirsute-scabrous, canescent; calyx-lobes, lanceolate or ovate-lanceolate, 5–10 mm. long, acuminate, scabrous, variously curved and reflexed, frequently persistent on the fruit, dark green; petals 5, obovate, 1–1.5 cm. long, shortly apiculate, pilose at the apex, otherwise glabrous; stamens 40–45, in 2 series, filaments narrowly linear, 7–9 mm. long; style 1 mm. long, filiform, angled, papillose at the apex, persistent in fruit; capsule obconical to subcylindrical, brownish-gray, scabrous, irregularly plicate, rugose; seeds about 10, pendulous, irregularly ovate to ovate-oblong, grayish-yellow, densely tuberculate-verrucose, not winged.

Distribution: dry, sandy or limestone habitats, Texas southward into Mexico.

Specimens examined:

TEXAS: Comal Co., without date, *Matthes 392* (V); indefinite locality, *Wright* (P); indefinite locality, Aug. 1845, *Lindheimer 396* (M, V); indefinite locality, May–Oct. 1849, *Wright 210* (US); western Texas, 1851, *Parry* (ANSP); Llano Co., 1861, *Buckley* (ANSP); western Texas, 1883, *Havard* (US); Uvalde Co., June 1885, *Reverchon 1650* (M, US); Limpia Cañon, 1889, *Nealley 660* (US); Corpus Christi, Nueces Co., 28–31 May 1894, *Heller 1791* (ANSP, C, P, US); shady rocks, Devil's River, Valverde Co., 11 Sept. 1900, *Eggert* (M); Corpus Christi, May 1913, *Orcutt 5940* (M); vicinity of Corpus Christi, Oct. 1913, *Rose 18081* (US); shaded limestone cliffs, Concan, Uvalde Co., 14 June 1916, *E. J. Palmer 10205* (M); Pleasanton, Atascosa Co., 23 Sept. 1916, *E. J. Palmer 10786* (M); Nabbs Ranch, Palm Grove, Nov. 1923, *Runyon 583* (US).

MEXICO: Cerro de Berrego, Oaxaca, without date, *Mohr 144* (US); Walnut Grove, Monterey, 26 May 1847, *Gregg 782* (M); Cochuto, Sonora, 5100 ft. alt., 4 Oct. 1890, *Hartman 93* (US); Oaxaca Valley, State of Oaxaca, 5000 ft. alt., 23 Oct. 1894, *Smith 827* (M, US); San Luis Potosi and vicinity, July–Aug. 1898, *Palmer 648* (US); Tehuantepec, July 1900, *Gonzalez* (V); Oaxaca, 1750 m. alt., July–Aug. 1900, *Conzatti & Gonzalez 19* (M, US); near Tehuacan, Puebla, 30 Aug.–8 Sept. 1905, *Rose, Painter & Rose 10017* (M); Santa Ana, Oaxaca, 1700 m. alt., 19–23 June 1906, *Conzatti 1458* (US); vicinity of Victoria, Tamaulipas, 320 m. alt., May–June 1907, *Palmer 404* (F, M, US); Cerro San Antonio, Oaxaca, 18 Aug. 1907, *Conzatti 1985* (F); Tlaxcola, 2200 m. alt., 20 July 1910, *Arsène & Nicolas 5291* (K, M, US); Telmacan, 7 Sept. 1919, *Reko 4228* (US); Cerro de los Armadillos, vicinity of San Jose, 9 July 1930, *Bartlett 10188* (MH).

**15. M. adhaerens** Benth. Bot. Voy. Sulph. 15. 1844; Walp. Rep. 5: 776. 1845-46; Urban & Gilg in Nov. Act. Nat. Cur.

[Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 51. 1900; Johnston in Proc. Cal. Acad. Sci. IV. **12**: 1103. 1924.

Annual or biennial plants, from a slight tap-root, extremely scabrous or hispid throughout, .7–7 dm. high; stems mostly slender, flexuous, trichotomously branched near the base, dichotomously branched above, white or ochroleucous, epidermis scarious, scaling on mature plants, scabrous with glochidiate hairs below, more densely hispid with glochidiate and spine-like hairs above; leaves alternate, thin, round-ovate, 2–8 cm. long, 1–5 cm. broad, coarsely dentate to sinuate-lobate, more or less incised, irregularly 3–5-lobed, acute at the apex, cuneate at base, hispid with short glochidiate hairs on under surface, especially along the veins, upper surface armed with a few spine-like or anchor-like hairs; lower leaves petiolate, petioles 1–6 mm. long, upper leaves subsessile; flowers borne singly in axils of dichotomous branches, subtended by small leafy scabrous roundish bracts, sessile or very short-pedicelled; calyx-lobes 5, dark green, acute or acuminate at apex, nearly equalling the petals in length, dorsal surface covered with long spine-like hairs interspersed with short stiff glochidiate hairs; calyx-tube obconical to turbinate, attenuated at base, pedicelled, hispid with long slender spine-like and glochidiate hairs, 5–7 cm. long; calyx-lobes reflexed or straight, persistent, rugose, tuberculate, covered with long spine-like and anchor-like hairs; petals 5, pale to golden-yellow, obovate to oblong-obovate, spreading, 1–1.5 cm. long, .5–1.0 cm. broad, gradually narrowed toward the base, apex short-apiculate and somewhat pilose; stamens 30–40, in 2 series, filaments narrowly linear to filiform, 7–8 mm. long, anthers oblong; style filiform, 3-parted, stigmatic lobes densely papillose, persistent and withered in fruit; mature capsule obconical to turbinate, brownish-yellow, pedicellate; seeds 10–13, in 1 or 2 series, pendulous, ovate to round-ovate, mottled yellow, irregularly striate and tuberculate-verrucose, not winged.

Distribution: in sheltered places, common on rocky or gravelly situations, in Lower California and on islands in the Gulf of California.

Specimens examined:

LOWER CALIFORNIA: Cedros Island, 1876, *Street* (US); Los Angeles Bay, Island of San Pedro Martir, 1887, *Ed. Palmer 402* (US); Carmen Island, 1–7 Nov. 1890, *Ed. Palmer 831* (US); La Paz, 20 Jan.–5 Feb. 1890, *Ed. Palmer 57* (US); Santa Agueda, 4–6 March 1890, *Ed. Palmer 254* (US); Cedros Island, March–June 1897, *Anthony 300* (M, D, US); Calmabia, washes, 1400 ft. alt., Jan.–March 1898, *Purpus 62* (RM); Espiritu Santo Island, 50–100 ft. alt., 7 Feb. 1906, *Nelson & Goldman 7508* (US); frequent over higher parts of San Pedro Martir Island, 18 April 1921, *Johnston 3156* (CAS, US); sandy draw, San Luis Gonzales Bay, 29 April 1921, *Johnston 3337* (CAS, US); uncommon on lava slopes, Tortuga Island, 11 May 1921, *Johnston 3604* (CAS); rocky ground at foot of bluff, Coyote Bay, 18 June 1921, *Johnston 4171* (CAS); sandy wash, 3 miles north of Willard's Point, 3 July 1921, *Johnston 4257* (CAS); La Paz, Feb. 9 and 25, 1928, *Jones 24307* (CAS, M, P); Todos Santos, on the north, 17 Feb. 1928, *Jones 24308* (CAS, M, P).

16. **M. floridana** Nutt. ex Torrey & Gray, Fl. N. Am. **1**: 533. 1840; Walp. Rep. **2**: 223. 1843; Dietrich, Syn. Pl. **3**: 85. 1843; Chapman, Fl. Southeast. U. S. ed. 3, 167. 1897; Small, Fl. Southeast. U. S. 809. 1903, and ed. 2, 810. 1913; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 53. 1900; Small in Addisonia **4**: 13, *pl. 127.* 1919.

Annual or perennial herbaceous plants, 2–10 dm. high; stems repeatedly dichotomously branched, reclining or occasionally erect, flexuous, slender, densely clothed with minute glochidiate-hispid hairs; leaves alternate, irregularly and rather distantly disposed on the stem, dull green, rotund-ovate to triangular-ovate, hastate, 2–7 cm. long, 1.5–5 cm. broad, coarsely toothed or lobed, acute or shortly acuminate at the apex, rotund or cuneate to subcordate at the base, narrowing abruptly into a dark green petiole 0.5–2 cm. long, impressed-veined and scabrous with spine-like hairs above, prominently veined and with more numerous glochidiate hairs beneath, especially along the veins; flowers near the apex, axillary, sessile; calyx-tube obconical, attenuate but not pedicellate below, about 8–15 cm. long, 3–5 cm. broad, densely covered with long unequal glochidiate hairs, intermixed rarely with spine-like hairs; calyx-lobes 5, imbricated, ovate-oblong, acuminate, lanceolate, 6–8 mm. long, 2.5–3 mm. broad at base, short-acuminate to acute at the apex, persistent, erect, becoming almost black at maturity; petals 5, imbricated, obovate, broadly cuneate to orbicular-cuneate, 1–1.5 cm. long, 0.8–0.9 cm. broad, concave, usually abruptly short-apiculate at the apex, gradually narrowed below, pilose near the apex, otherwise glabrous; stamens 30–35, in 2 series, filaments narrowly linear, 7–8 mm. long, anthers all equal, oblong or oval-oblong, laterally dehiscent; style 6 mm. long, filiform, glabrous, narrowed, 3 stigmatic surfaces with papillose margins near the apex, persistent in the fruit; capsule obconical, papery, attenuated into a pedicel 3–4 mm. long when young, at maturity 1.5–1.8 cm. in length; seeds 8–10, in 1 or 2 series, pendulous, irregularly ovate to ovate-oblong, yellowish mottled with brown, irregularly striate to densely tuberculate-verrucose, 2.5 mm. long, 1.8 mm. broad, not winged.

Distribution: in hammocks and clearings, Florida and the Bahama Islands.

Specimens examined:

FLORIDA: southern Florida, various collections without date, *Chapman* (ANSP, F, M, US); without definite locality or date, *Calkins* (US), and *Peale* (ANSP TYPE); Miami, without date, *Garber* (ANSP); Lake City, without date or collector's name, *Hitchcock Herb. 1366* (F); Manate, southwestern Florida, July 1845, *Rugel 252* (V); Indian River, 1874, *Palmer 181* (F, M, US); Cedar Keys, April 1876, *Garber* (F, US); Miami, April 1877, *Garber* (ANSP, F, US); shell islands at the mouth of St. John's River, Oct. 1878, *Curtiss 659* (ANSP, US), and *Curtiss 959* (CAS, F, M, US); on shell mounds, Manatee Co., 20 March 1887, *Rothrock* (ANSP, F, M); without definite locality, collection of 1889, *Simpson* (US); Lake Worth, 1 Feb. 1892, *Meehan* (ANSP); Palm Beach, 29 March 1895, *Canby* (US); hammocks, Palm Beach, 27 Dec. 1895, *Webber 255* (F, M); Palm Beach, 26 Dec. 1895–11 Jan. 1896, *Hitchcock 674, 675, 676, 677* (F); rich calcareous land, Miami, 28 March 1897, *Curtiss 5842* (F, M, US); Fort George, Duval Co., Oct. 1897, *Lighthipe 8431* (RM); Rockledge, 12–14 April 1897, *Crawford* (ANSP); Sneed's Island, 28 April 1900, *Tracy 6818* (F, M, US, V); Marco, July–Aug. 1900, *Hitchcock* (F); Fisherman's Key, 15 May 1901, *Tracy 7469* (F, M, US); sea-shore thicket, Brevard Co., 27 Oct. 1902, *Fredholm 5500* (RM, US); in hammocks, Miami, Nov. 1903, *Small & Carter 676* (ANSP, F); Miami, 18 March 1904, *Britton 9* (F); in hammocks, near Palm Beach, 19 Nov. 1904, *Small* (ANSP); east coast, 10 April 1904, *Burgess 778* (F); vicinity of Palm Beach, 15 Feb.–15 March 1908, *Garvens* (F); Knight's Key, 28–29 Jan. 1909, *Small & Carter 286* (ANSP); Captiva, Lee Co., 15 March 1915, *Orrok* (US); vicinity of Marco, Lee Co., 25 Feb. 1916, *Standley 12787* (US); dry thicket, Rockledge, Brevard Co., 8–18 March 1916, *Bartram* (ANSP); waste ground, Miami, 8 March 1917, *Meredith* (ANSP); coastal sand dunes, Lauderdale Beach, Brevard Co., 17 Dec. 1929, *Moldenke 256* (M).

BAHAMA ISLANDS: in sandy soil, Governor's Harbor, Eleuthera, 19–20 Feb. 1907, *Britton & Millspaugh 5516* (F).

**17. M. texana** Urban & Gilg, Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 52-53. 1900.

Annual or biennial, 5–6 dm. high; stems solitary, erect, striate, yellow or brownish-yellow, scabrous, canescent; leaves alternate, ovate or ovate-triangular, 2–4 cm. long, remotely dentate, deeply incised to somewhat trilobed, acute at the apex, rotund at the base, shortly petiolate, upper and lower surface hirsute-scabrous, subcanescent; flowers at apex of branches, sessile; calyx-tube conical, attenuated, densely hirsute-scabrous; calyx-lobes lanceolate, acute or shortly acuminate at the apex, usually persistent on the fruit, almost black; petals 5, yellow, obovate, 7–9 mm. long, shortly apiculate, narrowed toward the base, apex pilose; stamens 20–25, in 1 series, all filiform or nearly linear; style persistent and withered on the fruit; capsule conical or subcylindrical, attenuated into a short pedicel or subsessile, 1.4 cm. long, brown, scabrous; seeds 7–8, pendulous, irregularly ovate to ovate-oblong, grayish-brown, striate, densely tuberculate-verrucose.

Distribution: southern Texas and Mexico.

Specimens examined:

TEXAS: indefinite locality, 1855, *Drummond 202* (V).

MEXICO: vicinity of Puebla, 2190 m. alt., 4 Oct. 1906, *Arsène 470* (M, US); Cerro Guadalupe, vicinity of Puebla, 2250 m. alt., 7 Nov. 1908, *Arsène 1863* (M, US); Rancho Posadas, Puebla, 1909, *Nicolas* (K).

**18. M. asperula** Wooton & Standley in Contr. U. S. Nat. Herb. **16**: 148-149. 1913.

Annual herbaceous plants with erect branching stems, 3–5 dm. high, scabrous at first, later becoming more or less smooth below; upper branches strongly ascending, lower branches divergent and then erect; leaves narrowly ovate to lanceolate, 3–5 cm. long, coarsely and irregularly serrate-dentate, frequently laciniately 2–4-lobed near the base, hispid on the upper surface with verticillate spine-like and glochidiate hairs, the under surface densely covered with minute and longer glochidiate hairs, especially along the prominent veins, attenuated into petioles 8–10 mm. long; flowers terminal, axillary, sessile, white or yellow; calyx-tube terete, short-clavate, elongating in fruit, densely hispid with barbed glochidiate hairs; calyx-lobes 5, narrowly lanceolate, 3–5 mm. long, acuminate at first, becoming subulate, more or less persistent until the fruit is mature; petals 5, ovate to obovate, 6–8 mm. long, short-apiculate, orange, early deciduous; filaments shorter than the petals, filiform, none dilated, 10–15 in number, anthers light yellow; fruit cylindric to long-clavate, 18–25 mm. long; seeds usually 8, pyriform to suborbicular or subrectangular, obscurely and bluntly angled, mottled grayish-brown, with parallel curved striae.

Distribution: shaded ravines, dry slopes, limestone hills in the mountainous regions of western Texas, New Mexico, Arizona and northern Mexico.

Specimens examined:

Texas: Limpia Canyon, 1889, *Nealley 659* (US); Valley of the Rio Grande, below Donna, *Parry, Bigelow, Wright, Shott 387* (US).

New Mexico: Trujillo Creek, Sierra Co., 14 Sept. 1904, *Metcalfe 1364* (CAS, F, M, P, US type); Van Patten's Ranch, Organ Mts., Dona Ana Co., 10 Sept. 1899, *Wooton* (US); Mogollon Mts., Catron Co., Sept. 1880, *Greene* (P); shady ravines, Burro Mts., 12 Oct. 1881, *Rusby 139* (ANSP, F, M); without definite locality, 1851, *Wright 1081* (ANSP, US).

Arizona: Davidson's Canyon, 10 Sept. 1884, *Pringle* (F, US); Paradise, Slope 1, 5500 ft. alt., 19 Sept. 1907, *Blumer 1669* (F, M, US, V); Bowie, 20 Sept. 1884, *Jones 4308* (CAS, F, P, RM, US); Santa Rita Valley, 6000 ft. alt., Aug. 1874, *Rothrock 642* (F, US); Santa Rita Mts., 4500 ft. alt., 24 Aug. 1903, *Jones* (P); Santa Rita Mts., 26 Sept. 1880, *Engelmann* (M); Nogales, 28 Aug. 1927, *Peebles, Harrison & Kearney 4668* (US); Huachuca Mts., 5500 ft. alt., 3 Sept. 1903, *Jones* (P); near Fort Huachuca, Sept. 1894, *Wilcox 431* (US); Baboquivari Canyon, 11 Oct. 1925, *Peebles, Harrison & Kearney 397* (US); Baboquivari Mts., 25 Sept. 1927, *Harrison 4765* (US); Baboquivari Mts., 19 Sept. 1929, *Jones 24963* (M).

Mexico: Soledad, Nuevo Leon, Feb.–Oct. 1880, *Palmer 351* (US); rocky hills near Chihuahua, 12 Sept. 1885, *Pringle 633* (ANSP, F, US); rocky hills near Chihuahua, 12 Nov. 1885, *Pringle* (V); hills near Chihuahua, 8 Oct. 1886, *Pringle 1077* (M); Durango and vicinity, April–Nov. 1896, *Palmer 484* (F, M, US).

**19. M. aspera** Linn. Sp. Pl. ed. 1. 516. 1753; Amoen. Acad. 5: 398. 1760; Willd. Sp. Pl. $2^2$: 1175. 1799; Juss. in Ann. Mus. Nat. Hist. 5: 18. 1804; Ait. f. Hort. Kew. 3: 302. 1811; Lunan, Hort. Jam. 1: 504. 1814; Spreng. Syst. 2: 601. 1825; DC. Prodr. 3: 343. 1828; Dietrich, Syn. Pl. 3: 85. 1843; Anderss. Galap. Veg. 222. 1854; Griseb. Fl. Brit. West Indies, 298. 1861; Gray in Proc. Am. Acad. 5: 158, 180. 1862; Brewer & Watson, Bot. Calif. 1: 235. 1876; Urb. Symb. Antill. 8: 457.

1920–21; Fawcett & Rendle, Fl. Jam. 5: 248. 1926; Small in Addisonia 15: 47, *pl. 504.* 1930.

*M. stipitata* Presl, Reliq. Haenk. 2: 40. 1835; Walp. Rep. 2: 224. 1843.

*M. pedicellata* Presl, Epim. Bot. 246. 1849.

*M. albicaulis* Torrey, Bot. Mex. Bound. Surv. 67. 1859, p.p. (ex Wats.).

*Acrolasia squalida* Hook. f. in Trans. Linn. Soc. Lond. 20: 222. 1851.

Annual herbaceous plants, generally straggling, sometimes erect; stems brownish-green, yellow, or nearly white, terete and longitudinally striate, covered with short verticillate glochidiate hairs intermixed with antrorse spine-like hairs, sparingly toward the base, more dense on the younger parts of plant; leaves alternate, lanceolate or ovate-lanceolate, widely ovate or triangular-ovate, 10–15 cm. long, 8 cm. broad, acute or short-acuminate at the apex, serrate or serrate-dentate or deeply incised in the middle part to almost three-lobed, base cuneate or abruptly narrowed into a petiole 2–5 mm. long, or subcordate to cordate, upper surface of leaves dark green, covered sparingly with long slender antrorse spine-like hairs, lower surface lighter green and densely covered with minute verticillate glochidiate hairs intermixed with longer ones; flowers sessile, axillary; calyx-tube terete, cylindrical, attenuated at the base, 6–11 mm. long, 2–3.5 mm. wide, covered with stiff verticillate glochidiate hairs; calyx-lobes 5, imbricated, lanceolate to linear-lanceolate, long-acuminate, 3–4 mm. long, 1–1.5 mm. wide, covered with long antrorse spine-like hairs, not persistent in the mature fruit; petals 5, obovate or oblong-obovate to obovate-orbicular, narrowed toward base, acute, 4–8 mm. long, 2.5–4 mm. wide, glabrous or hispid on the dorsal surface toward the apex; filaments 20–30, 1–2 series, exterior series always dilated and petaloid, spathulate, all fertile; anthers oblong or oval-oblong, laterally dehiscent; style filiform, 3-parted at apex, contorted, stigmatic surfaces papillose, sometimes persistent in fruit; capsule cylindrical or subcylindrical, 15–25 mm. long, 3–5 mm. wide, terete, inconspicuously striate, sessile, obtuse at the base, brownish-green, turning brown, scabrous, papery, 3-valved, with alternate placentae; seeds 6–9, pendulous, irregularly ovate-oblong or oblong to subrectangular, 2.5–3.5 mm. long, 1.5 mm. broad, mottled grayish-yellow, irregularly tuberculate, minutely but strongly undulate-striate, not winged.

Distribution: southern Arizona, southward to Brazil, Bolivia, the Galapagos Islands and the West Indies.

Specimens examined:

Arizona: Nogales, 28 Aug. 1927, *Peebles & Harrison 4730* (US).

Mexico: CHIHUAHUA—southwestern Chihuahua, Aug.–Nov. 1885, *Ed. Palmer 101* (ANSP, US); Guayanopa Canyon, Sierra Madre Mts., 3600 ft. alt., 24 Sept. 1903, *Jones* (P); near Chuichupa in the Sierra Madres, 4 Sept. 1899, *Townsend & Barber 407* (F, M, US); Sierra Madre, 6 Sept. 1899, *Barber & Townsend* (US); DURANGO—City of Durango and vicinity, April–Nov. 1896, *Ed. Palmer 484* (F); ZACATECAS—near San Juan Capistrano, 21 Aug. 1897, *Rose 2457* (US); SONORA—Hermosillo, 29 Oct. 1926, *Jones 22339* (P); LOWER CALIFORNIA—Cape St. Lucas, Aug. 1859–Jan. 1860, *Xantus 3b* (US); San Jose del Cabo, 23 Sept. 1890, *T. S. Brandegee 224* (ANSP, US); El Taste, 12 Sept. 1893, *T. S. Brandegee* (P); SINALOA—State of Sinaloa, 1922, *Ortega 4773* (US); Hacienda Labradas, vicinity of Labradas, 25 Sept. 1925, *Ferris & Mexia 5282* (CAS); NAYARIT—Maria Madre, Tres Marias Islands, 23 Oct. 1925, *Ferris 5660* (D, US); JALISCO—near Etzatlan, 2 Oct. 1903, *Rose & Painter 7549* (US); Bolanos, 10–19 Sept. 1897, *Rose 2896* (US); COLIMA—Colima, 20 Oct. 1910, *Orcutt 4531* (D, F, M); Colima, 24 Oct. 1910, *Orcutt 4534* (K); MICHOACAN AND GUERRERO—La Morena, 400 m. alt., 7 Dec. 1898, *Langlasse 704* (K, US); VERA CRUZ—Wartenburg, near Tantoyuca, Prov. Huasteca, 1858, *Ervendberg 206* (ANSP); OAXACA—vicinity of Cuicatlan, 1890–2500 ft. alt., 8–24 Oct. 1894, *Nelson 1661* (US); YUCATAN—Merida, 25 Nov. 1864, *Schott 41* (US); Merida, 10 Oct. 1865, *Schott 861* (M, US); Izamal, without date, *Gaumer 821* (CAS, D, F).

Central America: GUATEMALA—St. Thomas, 1841, *Friedrichsthal 378* (V); vicinity of Zacapa, Dept. Zacapa, 200–400 m. alt., Dec. 1906, *Pittier 1761* (US); PANAMA—low swampy ground, between Corozal and Ancon, Canal Zone, 10–30 m. alt., 3 Jan. 1911, *Pittier 2209* (US); around Gamboa, Canal Zone, 20–100 m. alt., Nov. 1911, *Pittier 4793* (US); Balboa Heights, 12 Jan. 1922, *Greenman & Greenman 5055* (M); Ancon Hill, Panama Canal Zone, 13 Jan. 1922, *Greenman & Greenman 5114* (M); brushy slopes, Sosa Hill, Balboa, Canal Zone, 27 Nov.–10 Dec. 1923, *Standley 25256* (US); coastal thicket, Bella Vista, 28 Nov. 1923, *Standley 25350* (US); open grassy slope, Ancon Hill, Canal Zone, 26 Nov.–9 Dec. 1923, *Standley 26360* (US); brushy slope, Gamboa, Canal Zone, 26 Dec. 1923, *Standley 28333* (US); near beach, Balboa, Canal Zone, Nov. 1923–Jan. 1924, *Standley 32150* (US); open bank, Darien Station, Canal Zone, 19 Jan. 1924, *Standley 31521* (US).

West Indies: HAITI—vicinity of Port au Prince, 1–2 April 1920, *Leonard 3457* (US); vicinity of Mission, Fonds Varettes, about 1000 m. alt., 17 April–4 May 1920, *Leonard 3612* (US); Port au Prince, 150 m. alt., 21 Oct. 1924, *Ekman H 2207*

(US); stream near the West Indies Co., vicinity of St. Michel de L'Atalaya, Dept. du Nord, 350 m. alt., 17 Nov. 1925, *Leonard 7079* (US); cultivated slope 6 miles north of L'Atalaya Plantation, vicinity of St. Michel de L'Atalaya, Dept. du Nord, 350 m. alt., 26 Dec. 1925, *Leonard 8478* (F, US); among rocks on bare hill near shore east of Bord de Mer, vicinity of Jean Rabel, 6 March 1929, *Leonard & Leonard 13792* (US); rocky slopes, east bank of River Cotes de Fer, vicinity of Jean Rabel, 31 Jan. 1929, *Leonard & Leonard 12714* (US); SANTO DOMINGO—without definite locality or date, *Bertero* (M); Rincon, Prov. Barahona, Oct. 1911, *Fuertes 1301* (K, US, V); JAMAICA—Kingston Street, 9 Dec. 1890, *Hitchcock* (M); Kingston, Nov. 1849, *Prior* (K); CURACAO—fields near Willemstad, 20–27 March 1913, *Britton & Shafer 2914* (F, US); without definite locality, 17 Feb. 1917, *Curran & Haman 29* (US); PORTO RICO—on the Adjuntas road, four miles from Ponce, 21 Nov. 1902, *Heller 6091* (ANSP, F, M, US); Rincon, near Calvarche, 7 Dec. 1886, *Sintenis 5620* (M, US); Coamo, 4 Nov. 1885, *Sintenis 2693* (US); San Idlefonso, Coamo Springs Road, 22 Nov. 1899, *Goll 704* (US); CUBA—eastern Cuba, 1859–60, *Wright 208* (V); Prov. Pinar del Rio, Baños San Vicente, 12–16 Sept. 1910, *Britton, Britton & Gager 7393* (F, US); Prov. Pinar del Rio, base of Sierra Guana, 26 Nov. 1911, *Shafer 10557* (F, M, US); side of trail, Prov. Pinar del Rio, Sierra Caliente, south of Sumidero, 15–16 Aug. 1912, *Shafer 13738* (ANSP, US).

SOUTH AMERICA: COLOMBIA—without definite locality or date, *Andrè 514* (K); Mayquetia, *Oslo 439* (V); Santa Marta, 250 ft. alt., Aug. 1898–1901, *Smith 477* (ANSP, F, M, US); La Manuelita, near Palmira, eastern side of Cauca Valley, State of Cauca, 1100–1302 m. alt., Dec. 1905–Jan. 1906, *Pittier 826* (US); Sierra de la Teta, without date, *Dawe 559* (K, US); vicinity of Cartagena, 1919, *Heriberto 23* (US); vicinity of Cartagena, 1919, *Heriberto 137* (US); Dept. Bolivar, vicinity of Cartagena, 2–5 Nov. 1926, *Killip & Smith 14042* (US); Palmos de Varela, Barranquilla and vicinity, 20 Dec. 1929, *Elias 779* (US); VENEZUELA—near Colonia del Tovar, 1854–55, *Fendler 453* (M); waste places, Lower Catuche Wood above Caracas, 1000–1200 m. alt., 2 Sept. 1917, *Pittier 7350* (US); vicinity of Valencia, State of Carabobo, 400–800 m. alt., 16 Aug. 1920, *Pittier 9027* (US); Curucuti, near Maiquetia, 1 June 1922, *Pittier 10352* (US); Las Mostazas, Miranda, on railroad beyond Los Teques, 963 m. alt., *Allart 188* (US); PERU—near Tarapoto, eastern Peru, 1855–6, *Spruce 4922* (K, V); Tarapoto, Dec. 1904, *Ule 6646* (K); Dept. Puna, Tablazo River, northeast of Talara, 29 March 1929, *Haught 217* (US); plain southeast of Hacienda La Choza, Tumbez, 100–200 m. alt., 28 Feb.–3 March 1927, *Weberbauer 7700* (US); ECUADOR—in tropical region, near Guayaquil, June 1928, *Mille 171* (US); oil camp between Guayaquil and Salinas, Prov. Guayas, 0–100 m. alt., 21–24 June 1923, *Hitchcock 20053* (US); Chanduy, without date, *Spruce 6463* (V); BOLIVIA—subtropical region, Milluguaya, Nord Yungas, 1300 m. alt., Dec. 1917, *Buchtien 4357* (US); vicinity of Cochabamba, 1890, *Bang 748* (F); Bermejo, 1400 m. alt., 2 Dec. 1903, *Fiebrig 2316* (K); BRAZIL—Cera, on low ground in interior of state, 26 May 1929, *Bolland 31* (K).

## SECTION II. BARTONIA Torrey & Gray

Section II. BARTONIA Torrey & Gray, Fl. N. Am. **1**: 534. 1840; Brewer & Watson, Bot. Calif. **1**: 236. 1876; Gilg in Engl.

& Prantl, Nat. Pflanzenfam. $3^{6a}$: 111. 1894; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 85. 1900.

Biennials or perennials; stems smooth or scabrous; leaves sessile, rarely petiolate, sinuate-dentate to deeply pinnatifid; flowers yellow, rarely white, often large, showy; petals 5 or 10; filaments numerous, 30–200, the outer filaments more or less dilated to petaloid and sterile; capsule oblong to turbinate, broad, attenuated, sessile to subsessile; placentae broad horizontal lamellae; seeds 50–80, in 2 series, horizontal, flattened, suborbicular-winged, granulate-punctate to almost smooth, opaque. Spp. 20–46.

## KEY TO THE SPECIES OF SECTION BARTONIA

A. Calyx-lobes long (10–40 mm. long).
B. Outer 5 filaments petaloid; floral bracts adnate to the calyx-tube.
C. Flowers large; petals 50–80 mm. long................*20. M. decapetala*
CC. Flowers small; petals 20–35 mm. long.....................*21. M. stricta*
BB. Outer filaments usually not petaloid; floral bracts free from the calyx-tube.
C. Petals 15–20 mm. long; capsule 15–20 mm. long........*23. M. Brandegei*
CC. Petals 50–80 mm. long; capsule 30–40 mm. long.........*22..M. laevicaulis*
AA. Calyx-lobes short (2–15 mm. long).
B. Capsule erect.
C. Outer filaments petaloid.
D. Leaves entire or slightly dentate.
E. Stem pubescent.
F. Leaves linear-oblong; stem and leaves persistently white-pubescent.
G. Leaves thick, margins revolute, grayish-green..*28 M. leucophylla*
GG. Leaves thin, margins not revolute, pale green....*43. M. oreophila*
FF. Leaves oblanceolate to ovate; stem and leaves not persistently white-pubescent ....................................*42. M. integra*
EE. Stem smooth, polished.
F. Petals spathulate, 10 mm. long.....................*24. M. polita*
FF. Petals oblanceolate, 6–8 mm. long................*25. M. argillosa*
DD. Leaves sinuate-dentate to pinnately toothed or lobed.
E. Flowers distinctly yellow.
F. Flowers greenish-yellow...........................*46. M. lutea*
FF. Flowers lemon-yellow to golden.
G. Upper leaves entire, lower leaves pinnatifid....*29 M. multicaulis*
GG. Upper and lower leaves pinnatifid or lobed.
H. Plants caespitose.............................*26 M. perennis*
HH. Plants not caespitose.

I. Petals obtuse.
J. Capsule 15–20 mm. long, base acute.......*36. M. multiflora*
JJ. Capsule 8–15 mm. long, base rounded.
K. Anthers minutely scabrous..........*41. M. pterosperma*
KK. Anthers glabrous.
L. Stems scabrous; calyx-lobes 6–8 mm. long.......................................*45. M. puberula*
LL. Stems nearly glabrous; calyx-lobes 9–11 mm. long.................................*44. M. longiloba*
II. Petals acute.
J. Capsule 7–10 mm. long....................*27. M. humilis*
JJ. Capsule 10–20 mm. long.
K. Leaves small, mostly less than 6 cm. long; petals 15 mm. or less long.
L. Stem simple at base; lobes of leaves short, broadly oblong.
M. Capsule 15–20 mm. long.............*37. M. pumila*
MM. Capsule 10–12 mm. long..*37a. M. pumila* var. *procera*
LL. Stem branched at base; lobes of leaves narrowly linear-lanceolate .....................*30. M. densa*
KK. Leaves large, more than 5 cm. long; petals 15 mm. or more long.
L. Stem erect at base; leaves divided to near midrib, lobes linear-oblong............*40. M. laciniata*
LL. Stem decumbent at base; leaves divided halfway to midrib, lobes ovate to triangular..*38. M. chrysantha*
EE. Flowers pale yellow to nearly white.
F. Petals 15–50 mm. long.
G. Petals 15–22 mm. long.
H. Lower leaves 10–20 cm. long, lanceolate, upper leaves broad at base ..................................*39. M. Rusbyi*
HH. Lower leaves less than 5 cm. long, upper leaves attenuated, mostly entire, crowded..................*35. M. strictissima*
GG. Petals 20–50 mm. long..........................*34. M. nuda*
FF. Petals 70–80 mm. long..........................*33. M. albescens*
CC. Outer filaments linear, not petaloid.......................*31. M. Torreyi*
BB. Capsule reflexed........................................*32. M. reflexa*

**20. M. decapetala** (Pursh) Urban & Gilg in Ber. Deut. Bot. Ges. **10**: 263. 1892; in Engl. & Prantl, Nat. Pflanzenfam. **$3^{6a}$**: 111. 1894, and ed. 2, **21**: 534. 1925; Britton & Brown, Ill. Fl. **2**: 459. 1897; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 89. 1900; Gray, Man. Bot. ed. 7. 588. 1908; Coulter & Nelson, Man. Bot. Rocky Mts. 324–325. 1909; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 432–434. 1915; Rydb. Fl. Rocky Mts. & Adj.

Plains, 570–572. 1922; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 362–363. 1925.

*M. ornata* Torr. & Gray, Fl. N. Am. **1**: 534. 1840.

*Bartonia decapetala* Pursh in Sims, Bot. Mag. **36**: *pl. 1487.* 1812.

*Bartonia ornata* Pursh, Fl. Am. Sept. **1**: 327. 1814; Nutt. Gen. **1**: 297. 1818.

*Bartonia superba* Barton, Fl. N. Am. **3**: *pl. 81.* 1823.

*Torreya ornata* Eaton, Man. Bot. ed. 7, 560. 1836; Wats. Bibl. Index, 391. 1878.

*Hesperaster decapetalus* (Pursh) Cockerell in Torreya **1**: 142. 1901.

*Touterea ornata* Eaton & Wright, N. Am. Bot. 454. 1840; Wats. Bibl. Index, 391. 1878.

*Touterea decapetala* Rydb. in Bull. Torr. Bot. Club **30**: 276. 1903.

*Nuttallia decapetala* Greene in Leaflets Bot. Obs. & Crit. **1**: 216. 1906.

Perennial from a long succulent fusiform root, stout, coarse, scabrous; stems solitary, erect, branched above 3–10 cm. high, striate to subangular, pale yellow to yellowish-brown, scabrous the entire length, with short closely appressed, ascending verticillate glochidiate and spine-like hairs; leaves alternate, lanceolate to oblong-lanceolate, 5–15 cm. long, acute, sharply and interruptedly sinuate-pinnatfid, upper sessile, lower narrowed to a petiolar base, upper and lower surfaces harsh and scabrous with stout appressed spine-like hairs; flowers usually solitary, sessile, terminal, large, yellowish-white and odorous, subtended by several deeply pinnatifid, long-attenuated bracts extending to about one-half the length of the calyx-lobes; calyx-tube oblong to turbinate-oblong, 20–30 mm. long, bracteolate, canescent, densely scabrous with long verticillate glochidiate and spine-like hairs; calyx-lobes 5, lanceolate, 25–40 mm. long, long-acuminate, persistent, with prominent midvein, inner surface pilose, outer surface with short stiff appressed verticillate spine-like hairs; petals 10, pale yellow to almost white, concave, lanceolate-ovate, acute at the apex, spreading, unguiculate, sparsely pilose at the apex, about twice the length of the calyx-lobes, inner 5 somewhat smaller, representing petaloid staminodia; filaments numerous (200), filiform, erect, in 4–5 series, 3.5–4.5 cm. long, anthers linear to oblong-linear, base emarginate, not contorted; style equalling length of stamens, filiform, angled, 5–7-parted, papillose at the apex and margins, early deciduous in the fruit; capsule oval to oblong, 3–4 cm. long, obtuse, attenuated toward the base, brownish-gray, scabrous, many-nerved, crowned by more or less erect persistent calyx-lobes; seeds in 2 series, horizontal, numerous, margined but not winged, obovate, 3 mm. long, convex, grayish-brown, minutely granulate-punctate.

Distribution: plains and foothills from western Iowa northwestward to Canada and Montana, south to Mexico.

Specimens examined:

INDEFINITE LOCALITY; Northwest Territory, Nicollet Expedition, *Geyer 200* (ANSP, M); Simpson's Cut, 7 July 1859, *Simpson's Expedition* (M); Missouri, *Rafinesque* (ANSP); banks of Missouri, 15 Sept. 1864, *Rothhammer 508* (US).

IOWA: Sioux City, 29 Aug. 1896, *Pammel 25* (CAS, F, M, RM, US).

NORTH DAKOTA: Medora, 9 Sept. 1891, *Wright* (RM); without definite locality, Sept. 1898, *Westergaard* (RM); Medora, Aug. 1909, *Bailey* (US); clay bluffs near Bismarck, 13 Aug. 1927, *Larsen 167* (ANSP, M).

SOUTH DAKOTA: common on sand hills, *Skinner 215* (RM); banks of Cheyenne River, Smithville, 8 Aug. 1891, *Williams* (M); Forest City, Aug. 1892, *Griffiths* (M, US); Running Water, Sept. 1892, *Thornber 1384* (M, US); Hot Springs, 3500 ft. alt., 9 Aug. 1892, *Rydberg 713* (US); Hot Springs, Sept. 1893, *Safford* (US); Hot Springs, 27 Aug. 1898, *Williams* (ANSP); bluffs of Missouri River, Evarts, 30 Aug. 1906, *Moyer 2520* (RM); South Cave Hills, Aug. 1910, *Fromme* (M); clay banks, Slim Buttes, Harding Co., 21 Aug. 1910, *Visher 251* (F, RM); along cut banks, Spearfish Beds, 7 miles west of Rapid City, 10 Aug. 1925, *Lee* (RM).

NEBRASKA: prairies, Belmont, *Weber* (M); on Missouri, near Yankton to St. Helena, *Bruhin* (M); common on bluffs and sand hills, Fort Pierre, 1854, *Hayden 40* (M); Grand Rapids, 18 Aug. 1893, *Clements 2843* (US); Muddy Gulch, Scotts Bluff Co., 3 Aug. 1900, *Baker* (M); clayey soils, Sioux Co., Aug.–Sept. 1927, *Kramer 201* (M); Franklin Co., 25 Aug. 1929, *Hapeman* (ANSP).

KANSAS: limestone hills, near Bogue, *Imler 49* (M); without definite locality, Sept. 1885, *Oyster 2801* (CAS); Rockport, 20 Aug. 1889, *Bartholomew* (M); naked clays of bluffs, Caldwell, 10 Sept. 1890, *Smyth 274* (US); red clay bluffs near river, Medicine Lodge, 12 Sept. 1890, *Smyth 299* (US); stony hills, Morton Co., 6 Aug. 1895, *Hitchcock 175* (M, RM, US).

OKLAHOMA: near Alva, 12 Oct. 1896, *Ward 53* (US); sandy open ground, Altus, Jackson Co., 26 Oct. 1917, *Palmer 13072* (M); near Duke, Jackson Co., 5 Aug. 1927, *Stratton 311* (M).

Texas: banks of Fish Creek, Dallas Co., Aug. 1897, *Reverchon 325* (F, M, US); banks of Fish Creek near Dallas, *Reverchon 959A* (CAS, F, M, US); Fish Creek, Dallas, July 1879, *Reverchon* (F); cultivated at Dallas, Aug. 1882, *Letterman 140* (M, US); Dallas, 450 ft. alt., 20 July 1882, *Letterman 171* (M); low sandy brakes, Chillicothe, 27 Sept. 1906, *Ball 1161* (US); sandy soil, Garza Co., Oct. 1923, *Ruth 1150* (US); dry banks of canyon, Post, Garza Co., *E. J. Palmer 14562* (M); Spur, 19 Oct. 1930, *Reed 3241* (US).

Canada: Alberta, Medicine Hat, Assiniboia, Aug. 1895, *Macoun 10650* (US).

Montana: indefinite locality, without data, *Fitch* (D, P, RM); *Fitch 39* (RM); *Fitch 77* (M); Great Falls, 1 Aug. 1885, *Anderson 161* (UM); Great Falls, 27 Aug. 1886, *Williams 54* (US); indefinite locality, 27 July 1890, *Blankinship 99* (US); Colgate, 6 Sept. 1892, *Sandberg, MacDougal & Heller 1033* (CAS, US); Glendive, Sept. 1892, *Sandberg* (P, RM); near St. Peters Hospital, Helena, July 1894, *Starz* (M); Emigrant Gulch, 6500 ft. alt., 22 Aug. 1897, *Rydberg & Bessey 4545* (F, US); Deep Creek Canyon, Big Belt Mts., 14 Aug. 1899, *Blankinship* (P, RM); Gardiner River, 26 July 1902, *Mearns 2333* (US); Harr, 15 Aug. 1902, *Mearns 3289* (US); sandy draw, Great Falls, 3000 ft. alt., 28 July 1906, *Blankinship 697* (F, UM, US); cut bank, 3 Sept. 1921, *Wooton* (US).

Wyoming: Fort Union, Yellowstone Park, 1852, *Carrey* (US); Smith's Fork, Yellowstone River, 10 May 1860, *Hayden* (M); Hot Springs, north of Gardiner, 26 July 1888, *Knowlton* (US); Big Horn Mts., Aug. 5, 1892, *Buffum 347* (RM); near Mammoth Hot Springs, Yellowstone Park, 6000 ft. alt., July 1893, *Burglehaus* (M, US); Fairbanks, 14 July 1894, *Nelson 486* (M, US); Platte River, 14 July 1894, *Nelson 3019* (RM); Parkman, 22 July 1896, *Nelson 2456* (RM); Devils Tower, 17 Aug. 1897, *Griffiths* (CAS, RM); Buffalo, 4000–5000 ft. alt., Oct. 1900, *Tweedy 3618* (RM); ditch banks, Jelm, Albany Co., 12 Aug. 1900, *Nelson 8074* (M, P, RM, US); railroad grade, Moorcraft, 2 July 1901, *Nelson 8549* (RM); Yellowstone Park, Aug. 1901, *Martin* (P); rocky hillsides, Red Bank, Big Horn Co., 22 July 1901, *Goodding 477* (M, P, RM, US); Fort Yellowstone, 28 July 1902, *Smith 102* (US); Mammoth Hot Springs, Yellowstone Park, 1900 m. alt., 28 July 1902, *Mearns 2357* (US); Mammoth Hot Springs, Yellowstone Park, 2 Aug. 1902, *Mearns 2754* (D, US); near Mammoth Hot Springs, Yellowstone Park, 4 Aug. 1902, *Mearns 2825* (US); near Mammoth Hot Springs, 1 mile post, Yellowstone Park, 1793 m. alt., 30 July 1902, *Mearns 2514* (US); hills southeast of Sheridan, 14 July 1913, *Sharp 380* (RM); hillside above Madison's Ranch, Clark, 4000 ft. alt., 3 Aug. 1925, *Pearson 279* (RM); New Haven, 1926, *Stinson 2* (RM).

Colorado: Monument Park, without date, *Walker* (F); Leadville, without date, *Schedin* (RM); near Canyon City, 1874, *Brandegee* (ANSP, F, M,); marl hills at Pueblo, 6 Sept. 1881, *Engelmann* (M); Pueblo, 1889, *Evermann* (US); Boulder Canyon, 2 miles west of Boulder, 4 Sept. 1892, *Baker* (P); Fort Collins, 10 June 1894, *Baker* (P); sandy creek bottoms, 7000 ft. alt., 10 Sept. 1900, *Vreeland 660* (RM); foothills near Fort Collins, Aug. 1900, *Smith* (US); plains west of Loveland, Larimer Co., 21 July 1900, *Osterhout 2204* (P, RM, US); plains and foothills near Boulder, 5000–6000 ft. alt., July 1902, *Tweedy 5144* (RM); dry hills, Greenhorn, Pueblo Co., 1900 m. alt., 2 Sept. 1921, *Clokey 4218* (ANSP, CAS, D, F, M, P, RM, US); Pawnee Buttes, Sligo, 2 Aug. 1925, *Johnston 133* (RM).

New Mexico: prairies between Red River & Rock Creek, 21 Aug. 1847, *Fendler*

*240* (C, M); Bear Canyon, Raton Range, 10 Sept. 1903, *Howell 189* (US); Colfax, 13 Aug. 1910, *Wooton* (US).

IDAHO: Salmon, Salmon River, 31 Aug. 1895, *Henderson 3948* (US).

MEXICO: Sonora, ex herbarium *Dr. Torrey* (US).

**21. M. stricta** (Osterhout) Stevens ex Jeffs & Little in Publ. Univ. Okla. Biol. Surv. [Prelim. List Ferns & Seed Pl. Okla.] **2**: 73. 1930; Coulter & Nelson, Man. Bot. Rocky Mts. 325. 1909 (in synonymy under *M. nuda* (Pursh) T. & G.).

*Hesperaster strictus* Osterhout in Bull. Torr. Bot. Club **29**: 174. 1902.

*Touterea stricta* Osterhout in Bull. Torr. Bot. Club **30**: 276. 1903; Rydberg, Fl. Colo. 236. 1906.

*Nuttallia stricta* Greene in Leaflets Bot. Obs. & Crit. **1**: 210. 1906; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 435. 1915; Rydb. Fl. Rocky Mts. & Adj. Plains, ed. 2. 572. 1922; Rydb. Fl. Prairies & Plains Cent. N. Am. 557. 1932.

Perennial, strict, branching above, scabrous with spine-like and verticillate glochidiate hairs; stems whitish, somewhat striated, hispid, 5–10 dm. high, leafy; leaves sinuate-dentate, linear to oblong-lanceolate, hispid on upper and lower surfaces with short stout barbed spine-like pustulate hairs; basal leaves 7–10 cm. long, obtuse, shortly petiolate, upper leaves smaller, sessile, apex acuminate, base cuneate; flowers corymbose, small, mostly solitary, pale yellow, subtended by several laciniate acuminate bracts; calyx-tube 10–15 mm. long, tapering when young, hispid, almost entirely concealed by bracts; calyx-lobes deltoid-acuminate, 10–20 mm. long, hispid, occasionally laciniately divided, simulating a subtending bract; petals 10, 2–3.5 cm. long, oblanceolate, acute, narrowed to a claw about one-third of the length; outer filaments dilated, antheriferous, nearly equalling length of petals, inner filaments filiform, in several series, less than half the length of outer ones, anthers oblong, 1 mm. long, glabrous; style 2 cm. long, slender, deeply 3-parted to two-thirds of its length, glabrous; capsule stout, oblong-cylindric, 2–3 cm. long, ribbed or striated, hispid, yellowish-brown, crowned with the withered persistent calyx-lobes and style; seeds numerous, flattened, obovate, 4–5 mm. long, wing-margined, minutely muriculate.

Distribution: plains and foothills from South Dakota to Texas, west to southern Montana and New Mexico.

Specimens examined:

SOUTH DAKOTA: indefinite locality, *Skinner 215a* (RM); Iron Springs, Bad Lands, 28 Aug. 1889, *Williams & Wilcox 372* (US); Hot Springs, 3500 ft. alt., 3 Aug. 1892, *Rydberg 714* (US); Hot Springs, Aug. 1893, *Macbride* (F, M); Hot Springs, Aug. 1898, *Williamson* (ANSP); clay banks, Shannon Co., 29 July 1924, *Over 15843* (RM); along draws, on plains, Fall River Falls, Hot Springs, 23 July 1924, *McIntosh 510* (RM); hillsides near Cascade Springs, Fall River Co., 24 Aug. 1925, *Over 16996* (RM); Rocky Valley, Hill Canyon, 8 miles northeast of Dewey, 28 July 1927, *Hayward 2444* (RM).

NEBRASKA: indefinite locality, 12 July 1851, *Hayden* (M); South Platte to Pale Creek, July 1856, *Engelmann* (M); on the Running Water, Sheridan Co., 1–10 July, 1886, *Hatcher* (C); Pine Ridge, 25 July 1889, *Webber* (M); prairies, Belmont, Dawes Co., 25 July 1889, *Webber* (US); sand draws, Deuel Co., Aug. 1890, *Rydberg* (US); McColligan Canyon, 22 Aug. 1891, *Rydberg 123* (US); Turner, 24 July 1893, *Clements 2772* (US); South Fork of Dismal River, 14 Aug. 1893, *Rydberg 1689* (US); Bridgeport, Cheyenne Co., 3700 ft. alt., 6 Aug. 1901, *Baker* (M); Scotts Bluff Co., 4100 ft. alt., 13 Aug. 1901, *Baker* (M); dry clay slopes along Lincoln Highway near Deep Spring, 27 Aug. 1926, *Heller 14296* (D, M); sandy prairies, July–Sept. 1927, *Kramer 166* (M).

KANSAS: Wallace Co., *Snow* (C, US); Arkalon, sand hills, 16 Aug. 1890, *Smyth 147* (US); Medicine Lodge, above bluffs, 12 Sept. 1890, *Smyth 307* (US); Gray Co., June 1891, *Carleton 328* (F); Syracuse, 19 July 1893, *Thompson 123* (C, M, US); Seward Co., Sept. 1893, *Gurney* (M); prairie, Logan Co., 27 July 1895, *Hitchcock 176* (M, RM, US); sand hills, Finney Co., 11 Aug. 1895, *Hitchcock 177* (US); Belvidere, 19 Sept. 1897, *Ward* (US); vicinity of Tribune, 18 Sept. 1912, *Rose & Fitch 17083* (US); sand hills, 13 miles southwest of Lakin, 13 July 1929, *Rydberg & Imler 912* (M).

OKLAHOMA: Greer Co., 19 July 1901, *White* (RM); sandy open places, Frederick, 4 July 1903, *Duncan 37* (M); near Fairvalley, Woods Co., 15 July 1913, *Stevens 1714* (D, M, US); near Alva, Woods Co., 23 July 1913, *Stevens 1765* (D, M, US); near Alva, Woods Co., 24 Sept. 1913, *Stevens 2843* (M, US); sandy open ground, Ryan, Jefferson Co., 22 July 1917, *E. J. Palmer 12603* (M); sandy soil near Headrick, Jackson Co., 25 Aug. 1927, *Stratton 306* (M).

TEXAS: *Fremont's Expedition 177* (M); indefinite locality, *Berlandier 590, 2000* (M); Vernon, *Reverchon* (M); Fort Smith to Rio Grande, 1853-54, *Bigelow* (US); bank of Brazos, Seymour, Baylor Co., Sept. 1897, *Reverchon 324* (F, M, US); western Texas, Aug. 1881, *Havard* (US); Canadian, 26 Aug. 1892, *Bailey* (US); prairies, Canadian, Hemphill Co., 11 Aug. 1900, *Eggert* (M); prairies north of Stanton, Martin Co., 13 June 1900, *Eggert* (M); prairies, north of Colorado, Mitchell Co., 9 June 1900, *Eggert* (M); Colorado, 16 Oct. 1902, *Tracy 8337* (F, M, US); Lelia, 25 June 1902, *Reverchon* (M); sandy plains, Estelline, 9 July 1903, *Reverchon 3836* (M, P, US); Texline, 6 Aug. 1903, *Howell 135* (US);

prairies, north of Vernon, Wilbarger Co., 18 Sept. 1903, *Eggert* (M); Palo Duro Canyon, Randall Co., 2 Sept. 1907, *Ball 1212* (US); Sweetwater, 31 Oct. 1913, *Wooton* (US); sandy open ground, Fredericksburg, Gillespie Co., 5 June 1916, *E. J. Palmer 10058* (M); dry open ground, Sweetwater, Nolan Co., 21 Oct. 1917, *Palmer 13048* (M); Pease River bottoms near Vernon, Wilbarger Co., 20 Aug. 1921, *Ferris & Duncan 3351* (CAS, M); 17 miles south of San Antonio, May 1921, *Schulz 573* (US); sandy waste ground, Garza Co., 30 June 1924, *Ruth 1204* (CAS); near Posey Canyon, Lubbock Co., 4 June 1930, *Demaree 7768* (M); Slaton, 24 Sept. 1930, *Reed 3230* (US).

MONTANA: Clear Creek, 14 miles above Glendrive, 25 July 1883, *Ward* (US); Glendrive, July 1892, *Aiton* (ANSP, D, F, RM).

WYOMING: head of Big Sandy, 18 July 1891, *Buffum 345* (RM); Grant, 8 July 1894, *Nelson 338* (M, RM, US); Cummins, 28 July 1895, *Nelson 1470* in part (P); Lance Creek, 10 July 1896, *Knowlton 165* (US); Deer Creek, Converse Co., 14 July 1901, *Nelson 8408* (M, RM, US); indefinite locality, 1901, *Nelson* (RM); New Castle foothills, 9 July 1927, *Hayward 2046* (RM).

COLORADO: Denver, *Smith*, (ANSP); Clear Creek, 1862, *Hall & Harbour 569* (ANSP, F); indefinite locality, 1862, *Hall* (US); Colorado Springs, Aug. 1871, *Meehan* (ANSP); Canyon City, 1871, *Brandegee 89* (C, M); plains near Denver, 20 Aug. 1871, *Smith* (ANSP); Platte River bottom, Denver, 17 July 1872, *Redfield 464* (ANSP, M); divide between Denver and Colorado Springs, 20 Sept. 1874, *Engelmann* (M); Middle Park, 1875, *Patterson* (F); Boulder, 1 Sept. 1875, *Henry* (M); along the Platte River, Denver, 5000 ft. alt., 20 Aug. 1878, *Jones 661* (P); Hot Springs, Canyon City, 30 Aug. 1881, *Engelmann* (M); Platte Valley below Greeley, 3 Aug. 1881, *Ward* (US); near Denver, 5200 ft. alt., Aug. 1884, *Letterman 169* (F, M); Manitou, 10 Aug. 1884, *Letterman* (M); Colorado Springs, 1886, *Bartlett* (C); Breckenridge, 1887, *Bereman 734* (M); Pueblo, 1889, *Evermann* (US); Colorado Springs, Sept. 1892, *Mulford* (M); Fort Collins, 5000 ft. alt., 29 July 1892, *Crandall* (M); rocky slopes, Manitou, El Paso Co., 6400 ft. alt., 4 Aug. 1892, *Sheldon 426* (US); Fort Collins, 5000 ft. alt., 4 July 1893, *Baker* (P); river flats, Fort Collins, 5000 ft. alt., 26 Aug. 1895, *Cowen 180* (US); Fort Collins, 5000 ft. alt., 6 July 1896, *Baker* (M, P); Boulder, 1896, *Andrews* (P); Denver, 1897, *Wislizenus* (M); plains near Denver, 5170 ft. alt., July 1899, *Holm* (M); dry plains near foothills, 5300 ft. alt., 11 Aug. 1899, *Crandall 1212* (C, F, UM); prairies near foothills, 26 July 1899, *Marshall 1213* (RM, US); New Windsor, Weld Co., 29 July 1899, *Osterhout* (CAS, RM); Windsor, Weld Co., 29 July 1900, *Osterhout 2320* (ANSP, P); Colorado Springs, July 1900, *Harper* (M); Manitou, July 1900, *Harper* (C); New Windsor, Weld Co., 3 July 1900, *Osterhout 2321* (US); near Greeley, Weld Co., Aug. 1901, *Osterhout 2488* (ANSP, RM); New Windsor, Weld Co., 11 July 1901, *Osterhout 2488* (P, US); Colorado Springs, 6000 ft. alt., 27 Aug. 1902, *Cooper 425* (RM); plains and foothills near Boulder, 5000 ft. alt., Oct. 1902, *Tweedy 5145* (RM); plains and foothills near Boulder, 5000–6000 ft. alt., July 1902, *Tweedy 5146* (RM); New Windsor, Weld Co., 19 July 1904, *Osterhout 2917* (RM); New Windsor, Weld Co., 4 Aug. 1905, *Osterhout* (RM); South Cheyenne Canyon, 11 Sept. 1905, *Glatfelter* (M); Hugo, 26 Aug. 1907, *Tidestrom 56* (US); Flagstaff Mt., near Boulder, 14 Aug. 1906, *Robbins 2572* (RM); along the railroad, near Boulder, 8 Aug. 1906, *Robbins 2534* (RM); plains, Boulder, 5300 ft. alt., 31 July 1906, *Daniels 678* (M); Hugo, 5 Aug. 1907, *Tidestrom 56* (US); Hugo, 24

Sept. 1907, *Tidestrom 667* (US); Colorado Springs, 1908, *Pace 436* (M); Littleton, Aug. 1909, *Clemens* (P, RM); plains, North Denver, 20 Sept. 1910, *Eastwood* (C); dry soil, Denver, 15 July 1910, *Blake 349* (RM); plains, North Denver, 20 Sept. 1910, *Eastwood 152* (CAS, M, US); arid plains, North Denver, 2 Aug. 1910, *Eastwood 16* (CAS, C, M, US); Windsor, Weld Co., 1 Aug. 1911, *Osterhout* (P); Boulder, Boulder Co., 19 Aug. 1912, *Vestal 464* in part (P); prairie, Pike's Peak region, 20 Aug. 1912, *Brumback & Davies 96b* (F); vicinity of La Junta, 16 Sept. 1912, *Rose & Fitch 13069* (US); dry soil, Denver, 5300 ft. alt., 9 Aug. 1915, *Clokey 2628* (RM); dry soil, Denver, 5100 ft. alt., 5 Aug. 1916, *Clokey* (D, F); Windsor, Weld Co., 1 Aug. 1916, *Osterhout* (RM); vacant lot, North Denver, 19 Aug. 1919, *Bethel & Payson 1616* (M, RM); Wray, Yuma Co., 1100 m. alt., 11–15 Aug. 1919, *Eggleston 15542* (F, P); Florence, Fremont Co., 1000 m. alt., 2–5 Aug. 1919, *Eggleston 15417* (F); prairie, Denver, 5300 ft. alt., 2 Sept. 1917, *Clokey 2947* (CAS, F, RM, US); dry prairie, Denver, 1616 m. alt., 7 Sept. 1920, *Clokey 3822* (ANSP, CAS, D, F, M, P, RM, UM, US).

NEW MEXICO: without definite locality, coll. of 1847, *Fendler 241* (M); Cross L Ranch, Cimarron Canyon, 21–24 Aug. 1903, *Griffiths 5548* (US); northeast of Clayton, 19 Aug. 1910, *Wooton* (US); Nara Vista, 7 Oct. 1910, *Fisher 95* (US); Nara Vista, 10 July 1914, *Wooton* (US).

22. **M. laevicaulis** (Dougl.) Torrey & Gray, Fl. N. Am. **1**: 535. 1840; Watson, U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 114. 1871; Brewer & Watson, Bot. Calif. **1**: 237. 1876; Coulter, Man. Bot. Rocky Mt. Region, 107. 1885; Greene, Fl. Francisc. 234. 1891; Greene, Man. Bot. Reg. San Francis. Bay, 142. 1894; Gilg in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{6a}$: 111. 1894; Howell, Fl. N. W. Am. **1**: 241. 1897; Britton & Brown, Ill. Fl. **2**: 459. 1897; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 87. 1900; Jepson, Fl. West. Mid. Calif. 323. 1901; Abrams, Fl. Los Angeles & Vic. 256. 1904; Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 395. 1906; Coulter & Nelson, Man. Bot. Rocky Mts. 326. 1909; Piper & Beattie, Fl. Southeast. Wash. & Adj. Idaho, 166. 1914; Rydb. Fl. Rocky Mts. & Adj. Plains, ed. 2. 570–572. 1922; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 362–363. 1925; Jepson, Man. Fl. Pl. Calif. 649. 1925.

*M. ornata* Torrey in Rept. Stansb. Exped. 387. 1852, not Torrey & Gray.

*M. laevicaulis* (Dougl.) Torrey & Gray var. *acuminata* Nels. & Macbr. Contr. Gray Herb. 65: 40. 1922.

*M. acuminata* Tidestr. in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 362. 1925.

*Bartonia laevicaulis* Dougl. in Hook. Fl. Bor. Am. **1**: 221, *pl. 69.* [1834] 1840; Hook. & Arn. Bot. Beechey Voy. Suppl. 343. 1843; Walp. Rep. **2**: 224. 1843.

*Bartonia parviflora* Dougl. in Hook. Fl. Bor. Am. **1**: 221. [1834] 1840.

*Bartonia ornata* Hook. in Lond. Jour. Bot. **6**: 226. 1847, not Pursh.

*Hesperaster laevicaulis* Cockerell in Torreya **1**: 143. 1901.

*Touterea parviflora* Rydb. Bull. Torr. Bot. Club **30**: 276. 1903.

*Touterea laevicaulis* Rydb. *Ibid.*

*Nuttallia laevicaulis* (Dougl.) Greene, Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

*Nuttallia parviflora* (Dougl.) Greene, *Ibid.*

*Nuttallia acuminata* Rydb. in Bull. Torr. Bot. Club **40**: 61. 1913.

Perennial, coarse, stout; stems erect, 3–10 dm. high, branched, striate, shining white, nearly smooth below, scabrous with a few verticillate glochidiate and spine-like hairs above; leaves alternate, 3–15 cm. long, sessile, scabrous, canescent with short retrorse and antrorse spine-like hairs on upper surface, verticillate glochidiate hairs on lower surface; basal leaves oblanceolate, deeply pinnately lobed nearly to midvein, upper leaves ovate-lanceolate, acute or acuminate at apex, base subcordate, sinuate-pinnatifid; flowers 1–3, terminal, sessile, large, showy, pale yellow, expanding in bright sunshine, subtended by 1–3 linear-subulate irregularly toothed long-acuminate bracts; calyx-tube cylindrical, attenuated, 15–30 mm. long, densely scabrous; calyx-lobes lanceolate to ovate-oblong, acuminate, 20–40 mm. long, canescent, pubescent, reflexed and yellowish in fruit, conspicuous midnerve; petals 5, yellow, lanceolate or oblong-lanceolate, erect or spreading, 5–8 cm. long, narrowed at the base, acute or acuminate and slightly pilose at the apex, otherwise glabrous; stamens in 4–5 series, 2–4 cm. long, filaments antheriferous, 5 exterior filaments dilated, somewhat petaloid, anthers not contorted, oblong-linear; style 3.5–6 cm. long, papillose, persistent and withered in fruit; capsule subcylindrical, slightly attenuated, obtuse at the base, 3–4 cm. long, scabrous, brownish-black, strongly striated, crowned by persistent recurved calyx-lobes and withered style; seeds numerous, in 2 series, short-obovate to obovate-rotund, 2–3.5 mm. long, winged, slightly convex, grayish-brown, minutely granulate-punctate, tuberculate.

Distribution: canyons, valleys, and dry foothills, from Montana westward to the Pacific Coast.

Specimens examined:

Indefinite Locality: "Head of the Missouri" and "Columbia River Blue Mountains," *Nuttall* (ANSP); Franklin Gap, *Hooker* (ANSP type); Fort Beaufort, *Havard* (F).

Montana: Hot Sulphur Springs, 24 July 1871, *Allen* (US); Sixteen Mile Creek, 4500 ft. alt., 10 July 1883, *Lamson-Scribner 59, 60* (US); Helena, 24 July 1887, *Williams 686* (US); Lower Falls of the Missouri, 18 Sept. 1887, *Williams 727* (US); McCarthy, 1888, *Anderson* (US); bank of Big Hole River, near Willis, Oct. 1888, *Anderson* (UM); near Helena, 4 July 1891, *Kelsey* (F); Emigrant Gulch, 6500 ft. alt., 23 Aug. 1897, *Rydberg & Bessey 4546* (F, US); East Flathead, 15 Aug. 1899, *Jones* (C, RM, US); Gardiner River, 2 Aug. 1902, *Mearns 2761* (US); Yellowstone River near Gardiner, 6 July 1902, *Mearns 1541* (US); Yellowstone River near Gardiner, 20 June 1902, *Mearns 1259* (US); Gardiner River, 27 July, 1902, *Mearns 2346* (US); Deer Lodge Valley, 5000 ft. alt., 28 July 1905, *Jones* (P); dry hillsides, Anaconda, 5000 ft. alt., 12 Aug. 1906, *Blankinship 698* (C, F, M, RM, US); prairie, Lolo Valley, near Woodman, 9 July 1921, *Kirkwood 1212* (M, UM); Yellowstone Trail between Tarkio & Superior, 2800 ft. alt., 12 July 1924, *Kirkwood 1799* (UM); near East Entrance, Glacier Park, 30 June 1930, *Van Dyke* (CAS).

Wyoming: Hot Springs, 1872, *Platt* (US); dry creek bottom, North Fork Wind River, 12 July 1882, *Forwood* (US); Mount Evart, Yellowstone Park, 26 July *Tweedy 95* (US); near Marquette, 4 Aug. 1892, *Rose 118* (M, US); Garfield Peak, 1888, *Knowlton* (US); head of Big Goose Creek, Big Horn Mts., 15–24 July 1893, 29 July 1894, *Nelson 678* (M, P, RM, US); Gardiner River, 19 July 1899, *A. & E. Nelson 6000* (M, RM, US); plains between Sheridan and Buffalo, 3500-5000 ft. alt., 15 June–15 July 1900, *Tweedy 3617* (RM); Meyer's Ranch, south of Evanston, Bear River, 7000 ft. alt., 26 July–1 Aug. 1902, *Pammel & Blackwood 4046* (M); Gardiner River, near Ft. Yellowstone, 27 July 1902, *Smith 98* (US); Mammoth Hot Springs, 29 July 1902, *Smith* (F); Gardiner River Mt., 2 Aug. 1902, *Mearns 2761* (F); Yellowstone Park, 29 July 1902, *Mearns 3652* (US); Yellowstone Park, 27 July 1902, *Mearns 2356* (US); Slater, 20 July 1903, *Goodding 1725* (RM, US); Holm Lodge, Aug. 1911, *Reynolds 159* (F); Snake River below Jackson, Teton Co., 20 Aug. 1922, *Payson & Payson 3081* (RM); Shoshone Canyon, 10 Aug. 1924, *Nelson 10117* (M).

IDAHO: Ketchum, without date, *Broadhead 22* (P); without definite locality or date, *Wissels* (US); Palouse country and about Lake Coeur d'Alene, June–July 1892, *Aiton* (F, M, P, RM, US); Snake River, 2 July 1892, *Mulford* (M); Post Falls, Kootenai Co., 14–17 July 1892, *Heller 651* (ANSP, F); banks of Spokane River, Kootenai Co., 15 July 1892, *Sandberg, MacDougal & Heller 651* (CAS, F, M, P, US); sandy banks, Kootenai Co., July 1892, *Sandberg* (C, F, M); shores of Lake Coeur d'Alene, 18 July 1895, *Leiberg 1320* (C, F, M, P, RM, US); dry bluffs, Bay Horse Creek, Custer Co., 1895, *Henderson 3743* (US); Bear Lake, 9 Aug. 1898, *Mulford 287* (M); Weiser, Washington Co., 2200 ft. alt., 7 July 1899, *Jones* (P); St. Anthony, 15 Aug. 1900, *Merrill 451* (US); Deer Sawtooth National Forest, 21 Aug. 1909, *Woods & Tidestrom 2807* (US); hillside, Boise, 2880 ft. alt., 6 Sept. 1911, *Clark 313* (C, F, M, P, RM, US); volcanic boulder banks, King Hills, Elmore Co., 2580 ft. alt., 17 July 1911, *Nelson & Macbride 1164* (C, F, M, P, RM, US); shore, Lake Coeur d'Alene, near Silver Beach, Aug. 1912, *Rust 181* (US); Pocatello, July 1921, *Soth P–120* (RM); Pocatello, 1926, *Donaghe 52* (CAS); slopes near Riggin, July 1926, *Rhodenbaugh 12* (RM); Downey, 23 Aug. 1931, *Howell 7940* (CAS).

UTAH: without definite locality, *Vasey* (F); Thompson Creek, 7 July 1859, *Engelmann* (M); mountains west of Camp Floyd, pass near Rush, 4 Aug. 1859, *Engelmann* (M); Glenwood, 10 June 1875, *Ward 216* (F, M, US); Kane Co., 1875, *Siler* (M); without definite locality, 1877, *Palmer 170* (M); City Creek Canyon, 5300 ft. alt., 25 July 1879, *Jones 1462* (P); Milford, 17 June 1880, *Jones* (P); American Fork Canyon, 4 Aug. 1880, *Jones* (P); City Creek Canyon, Salt Lake City, 26 July 1883, *Summers* (US); Fish Spring, 4 June 1891, *Jones* (P); Provo, 6000 ft. alt., 10 July 1894, *Jones 5609* (C, F, M, P, RM, US); Panguitch Lake, 8400 ft. alt., 6 Sept. 1894, *Jones 6002t* (P); Logan Canyon, 15 June 1897, *Williams* (CAS); Diamond Valley, 4000–5000 ft. alt., May–Oct. 1898, *Purpus 6190* (C); Logan Canyon, 18 July 1898, *Mulford 169* (M); American Fork Canyon, 20 June 1902, *Goodding 1171* (M, RM, US); Salt Lake City, 16 Aug. 1902, *Cooper 4200* (RM), Ogden Canyon, 5000–6000 ft. alt., 17 July 1902, *Pammel & Blackwood 3749* (M); Salt Lake City, 16 Aug. 1902, *Cooper 4200 (366)* (RM); along Sevier River, below Marysville, 20 July 1905, *Rydberg & Carlton 6960* (RM, US); Beck's Hot Springs, Salt Lake Co., 4500 ft. alt., 19 July 1905, *Garrett 1495* (RM); Fort Douglas, 4 Oct. 1909, *Clemens* (CAS, RM); Hot Springs, 17 Aug. 1909, *Clemens* (RM); Logan Boulevard, Cache Co., 2 Aug. 1909, *Smith 1961* (RM); Salt Lake City, 27 June 1916, *Eastwood 7719* (CAS); Sevier Station, Sevier Co., 1680 m. alt., 21 Sept. 1918, *Eggleston 14936* (US); north of Salt Lake City, 13 Sept. 1924, *Garrett 3232* (RM).

NEVADA: ravine near Virginia City, Sept. 1863, *Bloomer* (US); near Virginia City, 1863–64, *Bloomer* (US); Ruby Valley, 6000 ft. alt., Aug. 1868, *Watson 432* (US); without definite locality, 1872, *Wheeler* (US); near Virginia City, 1874, *Moore* (M); Muncy, 6 July 1891, *Jones* (P); Spencemont, 20 July 1891, *Jones* (P); Quinn River Crossing, July 1901, *Griffiths & Morris 390* (US); ridge above Cave Creek post-office, Elko Co., 6250 ft. alt., 20 Aug. 1908, *Heller 9520* (ANSP, M, US); west side of Walker Lake, Mineral Co., 16 Aug. 1927, *Haley* (CAS); ridge, north side Lee Canyon, Charleston Mts., Clark Co., 8700 ft. alt., 2 Aug. 1913, *Heller 11053* (ANSP, F, M, US); vicinity of Austin, 1950 m. alt., 26 July 1913, *Hitchcock 721* (US); vicinity of Austin, 1950 m. alt., 25 July 1913, *Hitchcock 651*

(US); Hunters Canyon, vicinity of Reno, 1350–1500 m. alt., 18 July 1913, *Hitchcock 572* (US); Charleston Mts., Clark Co., 7000 ft. alt., 12 Sept. 1925, *Jaeger* (P); Charleston Mts., 3 July 1927, *Jones* (P); five miles west of Reno, 26 Aug. 1931, *Howell 8005* (CAS, M).

OREGON: indefinite locality, *Hopkins* (US); indefinite locality, 1871, *Hall 199* (F, M); Camp Harvey, 1875, *Bartholf* (M); gravel bars, eastern Oregon, Aug. 1880, *Howell* (F); The Dalles, Oct. 1881, *Howell* (US); Lost Valley, Gilliam Co., 940 m. alt., 9 Sept. 1894, *Leiberg 886* (C, US); near Pendleton, 1000 m. alt., 3 Sept. 1896, *Leiberg 2633* (US); Tygh Valley, Wasco Co., 31 Aug. 1897, *Coville & Applegate 738* (US); Ione, Morrow Co., 14 July 1903, *Lunell* (RM); Mitchell, Wheeler Co., 2975 m. alt., 1 Aug. 1917, *Lawrence 1028* (US); along Deschutes River, Crook Co., 17 Aug. 1919, *Whited 121* (M); along Deschutes River, 5 miles below Bend, 1 Aug. 1920, *Peck 9743* (ANSP, M); Illahe, 2000 ft. alt., 20 Aug. 1920, *Steward 304* (UM); highway, 5 miles south of the Dalles, Wasco Co., 28–30 July 1922, *Abrams 9502* (P); Rogue River bar at ferry, Curry Co., 24 Aug. 1924, *Peck 13682* (ANSP); Alvard, Harney Co., 22 July 1927, *Henderson 8844* (CAS); south of Kerby, Josephine Co., 15 Aug. 1928, *Gale 373* (ANSP, M).

WASHINGTON: Topmist Creek, 1882, *Brandegee 532* (C, M); without definite locality, 1889, *Vasey 232* (US); near the Columbia River, Klickitat Co., *Suksdorf 1679* (C, F, M, US); Coulee City, 31 Aug. 1892, *Lake & Hull* (M); near Egbert Springs, Douglas Co., 1300 ft. alt., 4 July 1893 *Sandberg & Leiberg 378* (ANSP, C, CAS, F, M, US); Spokane, Aug. 1893, *Piper* (M, RM); Spokane, 3 Sept. 1896, *Piper* (C); Waitsburg, 22 July 1897, *Horner 213* (US); grassy slopes, Mitchell Creek, 28 Aug. 1897, *Gorman 665* (US); without definite locality, 1897, *Sheldon 8182* (US); Leavenworth, Okanogan Co., July 1898, *Savage, Cameron & Lenocker* (F, M); Parker Bottom, 8 July 1901, *Cotton 433* (US); Parker, Yakima Co., 8 July 1901, *Cotton 433* (ANSP); near Prosser, Yakima Co., 9 Aug. 1902, *Cotton 808* (M, RM, US); Spokane, 9 Sept. 1902, *Kreager 529* (US); Yakima Ridge, Yakima Co., 18 July 1903, *Cotton 1408* (US); near Rockland, Klickitat Co., 3 Aug. 1904, *Suksdorf 4075* (F, M, US); Spokane, Spokane Co., 14 Sept. 1912, *Turesson* (RM); bank of Wenatchee River along railroad west of Leavenworth, 25 Aug. 1918, *Otis 845* (CAS); Tumwater Canyon, Chelan Co., 1300 ft. alt., 19 July 1921, *Otis 1081* (US); Naches River, 19 Aug. 1923, *Nelson 1554* (RM); Wilson Creek, Grant Co., 7 July 1923, *Spiegelberg 4* (RM).

CALIFORNIA: Fort Reading, *Newberry* (US); Indian Valley, Aug., *Lemmon* (C); Indian Mt., Plumas Co., *Lemmon 257* (F); Indian Valley, *Patterson* (F); Coyote Creek, Santa Clara Co., *Smith 3246* (RM); Antelope Hill, *Austin 1432* (US); without definite locality, *Bridges 116* (US); without definite locality, 1851, *Wislizenus* (M); Fort Miller, July 1853, *Heermann* (ANSP, US); without definite locality, 1860–62, *Brewer 2056* (US); near Camp 42, Idria, San Benito Co., 20 July 1861, *Brewer 769* (US); Puta Canyon, Yolo Co., 5 Aug. 1862, *Brewer 1315* (US); dry creek beds, Lake Co., 20 Sept. 1863, *Bolander 2677* (C, US); Santa Barbara Co., 1865, *Torrey 140* (US); Mono Lake, 1866, *Bolander 6256* (C, F, M, US); near Healdsburg, Sonoma Co., 27 Aug. 1872, *Redfield 121* (M); Big Trees of Calaveras, Aug.–Sept. 1872, *Torrey* (US); Sierra Co., 1874, *Lemmon* (M); Walkers Basin, 3440 ft. alt., 27 Aug. 1875, *Rothrock 281* (F, US); Mendocino Co., 1875, *Vasey* (F); near Yreka, Siskiyou Co., 16 Aug. 1876, *Greene 979* (M); Soda Springs, Plumas Co., July 1875, *Austin* (US); near Yreka, Siskiyou Co., 16 Aug. 1876, *Greene 979* (F); Yreka plains, 20 Aug. 1880, *Engelmann* (M); San Bernardino Mts., June 1880, *Parish* (M); Cucumonga Mt., San Bernardino Co., July 1882 *Parish & Parish 159* (ANSP, F, US); gravelly washes of Russian River, Ukiah, 14 Aug. 1882, *Pringle* (ANSP, US); Truckee, Sept. 1887, *Sonne 426* (ANSP); Hyampom, Humboldt Co., 25 July 1888, *Chestnut & Drew* (C); canyon on San Jacinto Mt., Riverside Co., 28 July 1890, *Gray 2108* (M); canyon on San Jacinto Mt., 28 July 1890, *Orcutt 2108* (M); Knight's Ferry, Stanislaus Co., 1890, *Sanford 173* (C); near Independence, Inyo Co., 14 June 1891, *Coville & Funston 956* (US); Putah Canyon near Devils Gate, July 1892, *Jepson* (C); near Pomona, 19 Nov. 1892, *Orcutt 2285* (M); bed of Clear Creek, Horsetown, 14 Sept. 1895, *Ward 69* (US); Soda Springs, Plumas Co., Aug. 1896, *Austin 855* (M, US); divide at head of Fandango Valley, 1750 m. alt., 31 July 1896, *Coville & Leiberg 137* (US); San Antonio Mts., 5800 ft. alt., 8 Aug. 1896, *Hall* (C); southwestern Colorado Desert, San Diego Co., July 1896, *Orcutt 2118* (US); San Jacinto Valley, June 1897, *Reinhardt* (C); Round Valley, Mendocino Co., 440 m. alt., 20 July–3 Aug. 1897, *Chestnut 594* (US); Pitt River Canyon, Sonoma Co., 12 July 1898, *Baker 548* (RM, US); near Sites, Glenn Co., May 1898, *Burtt-Davy 4278* (C); Santa Lucia Mts., Monterey Co., June 1898, *Plaskett 165* (US); Mendocino Co., Aug. 1898, *Brown 925* (ANSP, F, M, RM, US); Monrovia, Los Angeles Co., 9 Aug. 1900, *Abrams 872* (P); Tehipite Valley, Fresno Co., 4000 ft. alt., 6–10 July 1900, *Hall & Chandler 502* (C); Hupa Valley, July 1901, *Goddard 24* (C); Lytle Creek Canyon, San Bernardino Co., 2500 ft. alt., 13 July 1902, *Abrams 2686* (ANSP, C, M, P, US); near Pomona, Nov. 1902, *Babcock* (C); Redding, Sept. 1902, *Grant 5276* (C); Warner Mts., 30 July–6 Aug. 1902, *Griffiths & Hunter 388* (US); Eel River, 1 mile below Hullville, Lake Co., 1 Aug. 1902, *Heller 6008* (ANSP, F, M, P, RM, US); Welch's Canyon, Eureka Co., 15 Aug. 1902, *Kennedy 679* (RM); Claremont, Los Angeles Co., 1 Aug. 1902, *Palmer 3* (C); San Antonio Canyon, near Claremont, Los Angeles Co., 2 Aug. 1903, *Baker 3452* (C, CAS, F, M, P, RM, US); St. Helena, Sept. 1903, *Dunnock* (C); vicinity of Ione, 200–500 ft. alt., July 1904, *Braunton 1123* (ANSP, C, M, US); Nine Mile Creek, Fresno Co., 29 July 1904, *Culbertson 4681* (C, M, P, US); Forest Home, San Bernardino Co., 5500 ft. alt., Aug. 1904, *Smith* (US); dry beds of streams, San Bernardino Co., 6000 ft. alt., Aug. 1904, *Williamson* (ANSP); Mentone, San Bernardino Co., Aug. 1904, *Smith 2* (C); Princeton, Colusa Co., 17 Oct. 1905, *Chandler* (C); flood plain, Gurneyville, 30 Aug. 1907, *Cowles 1418* (F); Valley of Van Duzen River, opposite Buck Mt., Humboldt Co., 2500 ft. alt., 27 June–30 July 1908, *Tracy 2933* (C); Mill Creek, San Bernardino Mts., 6000 ft. alt., 25 July 1909, *Hall* (US); Downieville, 1909, *Kennedy 47* (CAS); near Yreka, Siskiyou Co., 17 July 1910, *Butler 1789* (M, P, RM, US); Pitt to Baird, Shasta Co., 25 July 1912, *Eastwood 1414* (ANSP, CAS); Sisson, Siskiyou Co., 20 July 1912, *Eastwood* (CAS); Pitt River, Shasta Co., 8 July 1913, *Smith 452* (ANSP, CAS); hills, 8 miles north of Oroville, 13 Aug. 1914, *Heller 11682* (CAS, F, M); Goodwin Ranch, Buckeye Creek, Yolo Co., 25 June 1916, *Stinchfield 337* (P); Klamath River above mouth of Shasta River, Siskiyou Co., 7 Sept. 1917, *Heller 12974* (ANSP, CAS, F, M, US); near Livermore, 1 July 1918, *Herrin* (CAS); Yreka, Siskiyou Co., Sept. 1919, *Overmann* (ANSP); lower slopes, San Jacinto Mt., 1800 ft. alt., 9 July 1919, *Spencer 1266* (CAS, P); near mouth of Mormon Creek, 8000 ft. alt., 28 July 1919, *Williamson 325* (P, RM); Klamath River at Terwah, Del Norte Co., 9 Sept. 1920, *Duncan 437* (ANSP, RM); San

Jacinto, June 1921, *Campbell* (CAS); Van Duzen River, on the road, 21 July 1921, *Eastwood 10667* (CAS); Woodlake, near Exeter, 20 Sept. 1921, *Kelley* (CAS); San Jacinto, 15 July 1921, *Jaeger 1168* (P, US); near Mono Flat, Santa Barbara Co., 3 July 1923, *Grant 1686* (M); ridge south of Swartout Valley, Los Angeles Co., 8450 ft. alt., 31 Aug. 1923, *Munz 7679* (P); Rialto, 19 Aug. 1924, *Jones* (P); dry uplands, Soda Bay, Clear Lake, Lake Co., 22 July 1926, *Blankinship* (CAS); near Pope Valley Creek, southwest Walter's Springs, Napa Range, Napa Co., 24 Aug. 1927, *Howell 3048* (CAS); Sisquoc River near Santa Maria, Sept. 1927, *Sinsheimer* (CAS); Jackrabbit Pass, 6 miles west of Beaumont, 8 June 1928, *Johnson* (CAS); Coyote Creek near Edenvale, Santa Clara Co., 5 Aug. 1928, *Smith 3246* (M); Chico, Sept. 1928, *Walther* (CAS); Kelseyville, Kelsey Creek, Lake Co., 9 Aug. 1929, *Blankinship* (M); Black Canyon, White Mts., 7000 ft. alt., 6 Aug. 1930, *Duran 549* (CAS, M); Markleville, Alpine Co., 5300 ft. alt., 7 July 1930, *Rose* (CAS, M); 3 miles east of Jacksonville, Tuolumne Co., 12 Oct. 1931, *Jussel* (CAS, M); Willow Creek, Humboldt Co., 30 June 1931, *Van Dyke* (CAS).

23. **M. Brandegei** Watson in Proc. Am. Acad. **20**: 367. 1885; Howell, Fl. N. W. Am. **1**: 239. 1897; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 86. 1900.

*Touterea Brandegei* (Wats.) Rydb. in Bull. Torr. Bot. Club **30**: 276. 1903.

*Nuttallia Brandegei* (Wats.) Greene, Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

Perennial or biennial, from a simple root, 2–3 dm. high; stems erect, yellow or yellowish-white, terete, striate, scabrous, branched; leaves abruptly linear-lanceolate, 2–5 cm. long, deeply sinuate-pinnatifid with linear lobes, scabrous on both surfaces, subcanescent, lower leaves somewhat petiolate, upper sessile; flowers terminating branches, corymbose, 1–3-flowered, sessile, subtended by shortly pedicellate, mostly entire, narrow bracts; calyx-tube subcylindrical, about 10 mm. long, densely hispid; calyx-lobes 30–40 mm. long, densely pubescent; petals 5, pale yellow, lanceolate, 15–20 mm. long, base narrowed, apex acute or acuminate, pilose, otherwise glabrous; stamens 30–35, in 2 series, the outer 5 filaments longer and wider, alternating with the petals, other filaments linear, filiform; style filiform, apex papillose, persistent and withered in fruit; capsule narrowly oblong-cylindrical or subcylindrical, 15–20 mm. long, brownish-black, scabrous; seeds horizontal, flattened, angular, rugose, narrow, scarcely winged margins.

Distribution: sandy places in British Columbia and Washington.

Specimens examined:

BRITISH COLUMBIA: Kamloops, 28 July 1890, *Macoun* (US); Xero, Ashcroft, 28 June 1907, *Cowles 221* (F, M); Spence's Bridge, Thompson River Canyon, 15 Aug. 1931, *Howell 7799* (CAS).

WASHINGTON: Walla Walla River, *Wilkes Expl. Exp.* (US); 1889, *Vasey 234* (US); sandy hills near Wenatchee, 30 July 1899, *Whited 1172* (US); rocky slopes near Rock Island, Douglas Co., 15 June 1931, *Thompson 6754* (M).

**24. M. polita** Nelson in Bot. Gaz. **47**: 428. 1909.

Perennial from a semi-woody tap-root; stems 2 to several, slender, erect, 2–4 dm. high, cymosely branched and grayish toward the summit, glabrous and ivory-white below; leaves entire, the lower narrowly spathulate-oblanceolate, often abruptly acute, sessile to subsessile, intermediate and upper leaves broadest at base, all obscurely papillose and covered with short spine-like barbed hairs; calyx-tube short-turbinate, 5 mm. long; calyx-lobes subulate, divaricate, persistent; petals white, spathulate, 10 mm. long; stamens numerous, the outer filaments dilated-petaloid, antheriferous, shorter than the petals; style short, not cleft at apex; capsule globose, seeds small, obovate-rotund, smooth.

Distribution: open places, hillsides and valleys in Nevada.

Specimens examined:

NEVADA: Candelaria, Esmeralda Co., *Shockley 227* (CAS); hillside washes, Las Vegas, 4 May 1905, *Goodding 2273* (M, RM TYPE); Muddy Valley, Lincoln Co., 1700 ft. alt., 7 May 1906, *Kennedy & Goodding 40* (US).

**25. M. argillosa** Darlington, n. sp.[35]

Perennial, 2–3 dm. high; stems numerously branched, glabrous, white; leaves sessile, entire, ovate-lanceolate, somewhat spathulate above, 2–2.5 cm. long, attenuated at the base, scabrous; flowers yellow, small, subtended by linear entire bracts; calyx-lobes ovate-lanceolate, 8 mm. long, acuminate, margins revolute; petals 6–8 mm. long, obovate, apex acuminate; stamens numerous, outer filaments dilated, the inner filaments linear; capsule turbinate, 5–8 mm. long, scabrous, brownish; seeds small, narrowly winged, brownish-yellow, punctate.

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[35] **M. argillosa** Darlington, sp. nov. Planta perennis, 2–3 dm. alta; caulibus multum ramosis, glabris, albis; foliis sessilibus, integris, ovato-lanceolatis, supra spathulatis, 2–2.5 cm. longis, ad basem attenuatis, scabris; floribus flavis, parvis, bracteis linearibus integris subtentis; calycis laciniis ovato-lanceolatis, 8 mm. longis, acuminatis, marginibus revolutis; petalis 6–8 mm. longis, obovatis, ad apicem acuminatis; staminibus multis, filamentis exterioribus dilatatis, interioribus linearibus; capsula turbinata, 5–8 mm. longa, scabra, brunnea; seminibus parvis, anguste alatis, brunneo-flavis, punctatis.—Vermillion, Utah, 5600 ft. alt., 16 July 1894, *Jones 5631* (M TYPE).

Distribution: clay soil, near Vermillion, Utah.

Specimens examined:

Utah: Vermillion, 5600 ft. alt., 16 July 1894, *Jones 5631* (M type).

**26. M. perennis** Wooton in Bull. Torr. Bot. Club **25**: 260. 1898; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 358. 1900.

*Hesperaster perennis* (Wooton) Cockerell in Torreya **1**: 143. 1901.

*Touterea perennis* (Wooton) Rydb. in Bull. Torr. Bot. Club **30**: 277. 1903.

Perennial, 2–3 dm. high; stems caespitose, erect or spreading above, white, terete, scabrous with retrorsely barbed hairs to almost glabrous, bark thin, white; leaves alternate, linear, 3–10 cm. long, 2–3 mm. wide, entire or dentate with about 10 rounded lobes, scabrous with barbed hairs; flowers terminal or in upper axils, and pseudocymose, pedicellate, subtended by small leafy bracts; calyx-tube turbinate, 5 mm. long; calyx-lobes 5, subulate, about 10 mm. long, scabrous, an indurated ring forming at base of segments; petals 10, oblanceolate, acute, 2 cm. long, entire, light lemon-yellow, the 5 outer ones 5 mm. broad, the inner a little narrower; stamens numerous, 5 outer filaments slightly expanded, same length as petals, inner ones shorter; style 1 cm. long, apex minutely papillose; capsule campanulate, cylindric, barely 1 cm. long, 4 mm. in diameter, with persistent calyx-lobes, scabrous; seeds numerous, flattened, elliptic, orbicular, winged.

Distribution: on clayey soils, New Mexico.

Specimens examined:

New Mexico: White Mts., Lincoln Co., 5400 ft. alt., 21 July 1897, *Wooton 184* (M, P, RM, US type); along Tularosa Creek, Round Mountain, Otero Co., 1897, *Wooton 184* (US); along Tularosa Creek, Round Mountain, Otero Co., 20 Aug. 1899, *Wooton* (US); along Tularosa Creek, Round Mountain, Otero Co., 20 July 1905, *Wooton* (US).

**27. M. humilis** (Gray) Darlington, n. comb.

*M. multiflora* (Nutt.) Gray var. *humilis* Gray in Smithson. Contr. [Pl. Wright.] 3: 74. 1852.

*M. pumila* (Nutt.) Torr. & Gray var. *humilis* (Gray) Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 93. 1900.

*Hesperaster multiflorus* (Nutt.) Cockerell in Torreya **1**: 143. 1901.

*Touterea humilis* (Gray) Rydb. in Bull. Torr. Bot. Club **30**: 277. 1903.

*Nuttallia gypsea* Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **16**: 149. 1913.

*Nuttallia humilis* (Gray) Rydb. in Bull. Torr. Bot. Club **40**: 61. 1913.

*Acrolasia humilis* (Gray) Osterh. in Bull. Torr. Bot. Club **49**: 183. 1922.

Perennial, herbaceous, caespitose, 2–4 dm. high; stems leafy, smooth and white below, branched and scabrous toward the apex; leaves green, oblong to oval-oblong, 2–4 cm. long, 1 cm. wide, pinnately divided into linear obtuse segments 1 mm. broad, narrowed, short-petiolate at base, the upper and lower surface covered with scattered recurved stout white barbed glochidiate hairs with bulbiform bases; flowers small, terminal, pedicellate, subtended by 1 or 2 small linear bracts; calyx-tube campanulate, 3–4 mm. long; calyx-lobes ovate-lanceolate, acuminate, later becoming triangular-subulate, 5 mm. long; petals lanceolate, 12–15 mm. long, 2–3 mm. broad, base tapering, apex acute; stamens numerous, the outer series of filaments dilated and petaloid, the inner series shorter; capsule semi-hemispherical, 7 mm. long; seeds numerous, flat, winged, minutely tuberculate.

Distribution: clay cliffs in open places, Colorado and Utah, south to Texas and New Mexico.

Specimens examined:

TEXAS: Odessa, Sept. 1881, *Havard* (US); Camp Charlotte, 1889, *Nealley 703 (154)* (F, US).

COLORADO: clay cliffs beyond Muddy River, Middle Park, 27 July 1875, *Patterson 41* (F); clay cliffs along Muddy River, Middle Park, 28 June 1876, *Patterson* (F, M, US); McCoys, along Grand R., July 1891, *Eastwood* (CAS); Sulphur Springs, Grand Co., 7 Aug. 1907, *Osterhout 3562* (RM); Paradox, Montrose Co., 5400 ft. alt., 21 June 1912, *Walker 157* (RM, US); West Paradox, Montrose Co., 5200 ft. alt., 22 Aug. 1920, *Payson 2323* (CAS, M, RM); western Montrose Co., 5000 ft. alt., 14 July 1924, *Payson & Payson 3930* (M, RM).

UTAH: Bennett Spring, May–Oct. 1896, *Purpus* (C); White River, 6000 ft. alt., 25 May 1908, *Jones* (P).

NEW MEXICO: "western Texas to El Paso," May–Oct. 1849, *Wright 214* (ANSP, US); Gallup, 20 July 1897, *Herrick 893* (US); McCarthy Station, 25 July 1889, *Munson & Hopkins* (US); Arroyo Ranch near Roswell, 1–4 Sept. 1903, *Griffiths 5724* (US); north of Gallup, 3 Aug. 1904, *Wooton 2800* (US); plains, 35 miles south of Torrence, 6000 ft. alt., 10 Aug. 1909, *Wooton* (US); Lakewood, 6 Aug. 1909, *Wooton* (US); Arroyo Ranch near Roswell, June 1914, *Griffiths* (US).

28. **M. leucophylla** Brandegee in Bot. Gaz. **27**: 448. 1889.

Biennial or perennial, 3–4 dm. high; stems several from a small tap-root, clothed with soft white pubescence; basal leaves linear-oblong, 6–8 cm. long, 1 cm. wide, attenuated at both ends, regularly sinuate-dentate, densely clothed on the upper and lower surfaces with short rigid upwardly barbed hairs, and with minute glochidiate hairs along the margin, cauline leaves oblong, 4 cm. long, 1–1.5 cm. wide, rounded at the apex, slightly acute, base cordate-clasping, slightly sinuate-dentate, densely short-hispid; flowers bright yellow, pedicellate, 1–8 mm. long, in a divaricately branched panicle; calyx-lobes triangular-acuminate, obtuse, 6 mm. long; petals broadly spathulate, apex slightly retuse and pubescent, 1 mm. long; outer series of stamens broadly petaloid, somewhat dentate above; capsule 8–10 mm. long and nearly as broad; seeds flat, narrowly margined.

Distribution: on slopes of dry arid canyons, Nevada.

Specimens examined:

NEVADA: Ash Meadows, May–Oct. 1898, *Purpus 6032* (ANSP, US TYPE); Sheep Mountain, May–Oct. 1898, *Purpus 6144* (C); between Owens and Lee Canyons, Clark Co., 5000 ft. alt., 24 July 1913, *Heller 10980*ª (ANSP, M).

29. **M. multicaulis** (Osterh.) Nelson in Coulter & Nelson, Man. Bot. Rocky Mts. 326. 1909.

*M. pumila* (Nutt.) Torrey & Gray var. *multicaulis* (Osterh.) Nelson in Coulter & Nelson, Man. Bot. Rocky Mts. 326. 1909.

*Touterea multicaulis* Osterh. in Bull. Torr. Bot. Club **30**: 236. 1903.

*Nuttallia multicaulis* (Osterh.) Osterh. in Muhlenbergia 8: 45. 1912.

Perennial, 2–3 dm. high, with numerous stems, much branched; stems whitish, shining, glabrate below, hispid toward the summit; lower leaves short-petiolate, less than 1 cm. long, pinnatifid, the divisions remote and entire, upper leaves narrowly linear, entire, sessile; flowers numerous at apex of branches, opening at sundown and closing in about a half hour, short-pedicelled; calyx-tube 10 mm. long, appressed-hispid; calyx-lobes deltoid, acuminate, about 10 mm. long; petals 5, 1–2 cm. long, golden-yellow, base narrowed into a short claw; stamens numerous, outer series petaloid; capsule hispid, 1–1.5 cm. long; seeds numerous, round, smooth, slightly margined, but not winged.

Distribution: open places, Colorado and northern New Mexico.

Specimens examined:

COLORADO: Wolcott, Eagle Co., 28 July 1898, *Shear & Bessey 5290* (US); Wolcott, Eagle Co., 21 June 1900, *Osterhout 2113* (P, US); Wolcott, Eagle Co., 17 July 1902, *Osterhout 2663* (CAS, P, RM).

NEW MEXICO: Rio de los Frijoles, Aug. 1910, *Robbins 8235* (RM).

**30. M. densa** Greene in Pittonia 3: 99. 1896.

*M. pumila* (Nutt.) Torrey & Gray var. *densa* (Greene) Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 357. 1900.

*M. multiflora* (Nutt.) Gray var. *densa* (Greene) Nelson in Coulter & Nelson, Man. Bot. Rocky Mts. 325. 1909.

*Hesperaster densus* (Greene) Cockerell in Torreya **1**: 143. 1901.

*Touterea densa* (Greene) Rydb. in Bull. Torr. Bot. Club **30**: 277. 1903.

*Nuttallia densa* (Greene) Greene in Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

Perennial, herbaceous, low, compactly and divaricately branched from the base, 2–3 dm. high, forming a hemispherical tuft; branches white and hispid, short-jointed and flexuous; leaves small, narrowly linear-lanceolate, sinuate-pinnatifid, hispid; flowers solitary or in clusters of 3 at the ends of the branches, golden-yellow, 3–4 cm. broad; calyx-tube oblong, striate; calyx-lobes linear-subulate, about half the length of the tube; petals 10, subequal, spathulate-lanceolate, acute; seeds round-ovoid, thin, flat, strongly winged.

Distribution: open, sandy places in southern Colorado.

Specimens examined:

Colorado: Grand Junction, 4500 ft. alt., 21 June 1894, *Jones 5472* (C, M, RM, US) and *5492* (M, P); Gunnison Mesa, Grand Junction, 15 May 1916, *Eastwood* (CAS); Grand Junction, 21 June 1918, *Eastwood 7222* (CAS).

**31. M. Torreyi** Gray in Proc. Am. Acad. **10**: 72. 1874; Brewer & Watson, Bot. Calif. **1**: 237. 1876; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 38–39. 1900; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **16**: 433-434. 1913; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah and Nev.] **25**: 364. 1925.

*M. acerosa* Jones, Contr. West. Bot. **17**: 30. 1930.

Perennial, caespitose plants, densely and tenaciously hispid, 0.5–1.5 dm. high; root thick, fleshy and straight; stems several, white, sparingly white-pubescent, with short spine-like and a few glochidiate hairs, branching freely, with short internodes, giving a tangled appearance, angled; leaves sessile, thick, 2–5 cm. long, coarsely pinnatifid, cleft at the base into 3, rarely 5, subulate-acuminate divisions, the central division terminating in a short spine, midrib very prominent, margins strongly revolute, pubescent with short stiff hairs; flowers yellow, solitary, axillary, shorter than the leaves; calyx-tube short, oblong, truncate; calyx-lobes 5, cleft below the middle, linear-subulate; petals yellow, spathulate-lanceolate to oblanceolate, 5 mm. long, densely pubescent on the outer surface; stamens about 25–35, all filaments filiform, inner series slightly shorter; style 3-parted, cleft to the middle, not twisted; capsule urceolate, ovate, contracted below the broad summit, 2–3 mm. long; seeds few, about 7–9, 1 mm. long, turgid, pyriform-oblong, pointed at the base, obscurely angled, subrugose, dark, shiny.

Distribution: sterile, saline plains of western United States.

Specimens examined:

Idaho: Bruneau, 23 June 1930, *Jones 25020* (M type of *M. acerosa* Jones).

Nevada: U. Spring, June 1913, *K. Brandegee* (C); Muncy, 4 July 1891, *Jones*

(C, CAS, P, RM, US); sterile saline plains, Humboldt Co., 1865, *Torrey 138* (US TYPE, V); Humboldt Desert, near Deephole Springs, *Lemmon* (C); Pyramid Lake, 1873, *Lemmon* (C); sandy soil, Hot Creek Valley, 3000–4000 ft. alt., May–Oct. 1898, *Purpus 6349* (US).

CALIFORNIA: without definite locality, 1875, *Lemmon 113* (US); northern part of volcanic tableland, Crooked Creek, Mono Co., 25 Aug. 1914, *Peirson 752* (PH); Sherwin Grade, Mono Co., 5500 ft. alt., 27 May 1925, *Feudge 1561* (P); on slides of fine pumice on the north shore of Mono Lake, Mono Co., 6450 ft. alt., 12 Aug. 1930, *Peirson 9200* (CAS, P, PH).

**32. M. reflexa** Coville in Proc. Biol. Soc. Wash. **8**: 74. 1892; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 40. 1900; Jepson, Man. Fl. Pl. Calif. 648. 1925.

Annual herbaceous plants, 0.5–2 dm. high, densely hirsute with short stiff barbed glochidiate and spine-like hairs; stems stout, branching diffusely from the base, erect or spreading, brownish-white, longitudinally striate; leaves alternate, linear-oblanceolate and petiolate below to ovate or slightly hastate, subsessile or sessile above, acute or obtuse at the apex, 2–6 cm. long, irregularly and deeply sinuate-dentate, nerves inconspicuous, upper surface sparsely hirsute with slender stiff spine-like hairs, lower surface densely hirsute with short stiff barbed glochidiate hairs; flowers usually solitary, small, more or less concealed by the leaves, in upper forks of the branches, small, 1–1.5 cm. long, and pedicellate; calyx-tube obovate, 7–10 mm. long, densely hirsute with long, antrorse spine-like and verticillate glochidiate hairs, pedicel 4–5 mm. long; calyx-lobes narrowly subulate, acute at the apex, 6–9 mm. long, densely hirsute with short stiff glochidiate hairs; petals 8, yellow, oblong-oblanceolate, somewhat acute at the apex, narrowed toward the base, nearly equalling the calyx-lobes in length, barbellate near apex, otherwise glabrous; stamens 9–15, in 2 series, somewhat dilated and abruptly narrowed at apex, 3–5 mm. long, anthers emarginate at base and apex; style stout, nearly as long as the petals, cleft one-third of its length; capsule obovate-oblong, yellowish-brown, crowned by the persistent erect yellowish calyx-lobes, pedicel reflexed at the apex; seeds 10–12, angularly obovate or pyriform, compressed, slightly constricted below the middle with a deep transverse groove on either face, opaque, muriculate.

Distribution: desert ranges in Death Valley, Inyo Co., California.

Specimens examined:

CALIFORNIA: INYO COUNTY: about 8 miles above Furnace Creek Ranch, Furnace Creek Canyon, Funeral Mts., 22 March 1891, *Coville & Funston 454* (US); Surprise Canyon, Panamint Mts., 700 m. alt., 21 April 1891, *Coville & Funston 709* (US TYPE); Panamint Canyon, 2000 ft. alt., 3 May 1897, *Jones* (P); Panamint Canyon, 4000 ft. alt., 4 May 1897, *Jones* (M, P, US); Funeral Mts., Death Valley, 1000 ft. alt., 8 April 1907, *Jones* (CAS, P); Amargosa Desert, 4000 ft. alt., 27 April 1907, *Jones* (P); Salt Spring, Death Valley, 17 May 1915, *Parish 10063* (C); alluvial fan, 5 miles south of Bradbury Well, Black Mts., 1 April 1928, *Howell 3606* (CAS); Kelso, San Bernardino Co., 3000 ft. alt., 2 May 1906, *Jones* (P); near Barstow, 2300 ft. alt., 1 May 1922, *Spencer 1941* (P); open sandy expanse of the Amargosa Wash, 33 miles north of Baker, 1 April 1928, *Peirson 7765* (PH); rocky slopes, 10 miles northwest of Riggs, Mohave Desert, 3 April 1928, *Munz & Hitchcock 10955* (P); rocky hills, Baker, San Bernardino Co., 920 ft. alt., 24 March 1932, *Peirson 9824* (M, PH, UM).

**33. M. albescens** (Gill.) Griseb. in Abh. Ges. Göttingen [Pl. Lorentz.] **19**: 102. 1874; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 91–92. 1900.

*M. Wrightii* Gray in Mem. Am. Acad. [Pl. Fendl.] **4**: 48. 1849.

*Bartonia albescens* Gill. ex Arn. Edinb. Jour. Nat. & Geogr. Sci. **3**: 273. 1831; Sweet, Brit. Fl. Gard. **2**: 182. 1833; Hook. & Arn. in Hook. Bot. Misc. **3**: 327. 1840.

*Bartonia sinuata* Presl, Reliq. Haenk. **2**: 38. 1835; Gay, Fl. Chile **2**: 428. 1846.

*Bartonia Wrightii* Walp. Ann. **2**: 656. 1851–52.

*Myriophyllum Wrightii* Gray in Hall, Pl. Tex. 9, ex. Wats. Bibl. Index, 391. 1878.

*Touterea Wrightii* (Gray) Rydb. in Bull. Torr. Bot. Club **30**: 276. 1903.

*Nuttallia Wrightii* (Gray) Greene, Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

*Nuttallia albescens* (Gill. & Arn.) Standley, Jour. Wash. Acad. Sci. **6**: 239. 1916.

Biennial from a fusiform root, 4–6 dm. high; stems simple, rarely paniculate, upright, white or grayish-white, striate, hirsute-scabrous; leaves alternate, oblong-lanceolate, 5–7 cm.

long, broadly sinuate-dentate to sinuate-pinnatifid, with 8–10 pairs of coarse, obtuse teeth, the lower leaves narrowed into a petiole, attenuate, the upper leaves with a truncate or subauriculate-dilated base, sessile, ovate-lanceolate or linear-lanceolate, scabrous and canescent on upper and lower surfaces; flowers cymose, terminating the ends of the branches, sessile, small, ochroleucous, subtended by 1–3 linear-subulate bracts 1–1.5 cm. long, at base of calyx-tube; calyx-tube attenuated at base, 10–20 mm. long, 3–4 mm. broad, densely hirsute-scabrous with verticillate-glochidiate hairs intermixed with a few spine-like hairs, brown or brownish-gray; calyx-lobes lanceolate to linear-lanceolate, acuminate, 2–3 mm. long, persistent, reflexed and withered on the fruit, yellowish; petals 5, lanceolate-spathulate, 7–8 mm. long, acute or shortly acuminate at the apex, slightly pilose, otherwise glabrous; stamens 30–40, in 2 series, 5 filaments of outer series petaloid, the other filaments linear-subulate, 4–6 mm. long, anthers not contorted; style about 4 mm. long, filiform, angled, densely papillose at the apex, persistent and withered in fruit; capsule subclavate-cylindrical, 2–2.5 cm. long, yellowish-brown, striate, hirsute-scabrous; seeds 50–60, in 1 or 2 series, oval-orbicular, 3–3.5 mm. long, grayish-mottled, minutely granulate-punctate, winged, membranaceous.

Distribution: dry habitats from Oklahoma southward through Mexico, Chile, and Argentina.

Specimens examined:

OKLAHOMA: vicinity of Fort Sill, 6 June 1916, *Clemens 11695* (M).

TEXAS: indefinite locality, *Wright* (ANSP); river bank, Austin, 16 May 1872, *Hall 227* (F, M, US); Austin, 1872, *Hall* (F, US); Austin, July 1882, *Letterman* (M, US); Limpia Canyon, 1889, *Nealley 156* (F); Del Rio, 13 June 1891, *Dewey* (US); Fairland-Grant Mt., 17 May 1920, *Tharp 841* (US); 15 miles northwest of Fort Davis, Jeff Davis Co., 16 June 1926, *Palmer 30976* (M).

MEXICO: Chihuahua, *Thurber* (US); Mexican Boundary Survey, Valley of Rio Grande, below Donana, *Parry, Bigelow, Wright & Schott 389* (US).

CHILE: Aconcagua, ex herb. *Philippi* (C, US); 1828–34, *Gay 357* (US); Rivadavia, Prov. Coquimbo, 800 ft. alt., Nov. 1923, *Werdemann 101* (C, F, M); Maipo, 1700 m. alt., 11 Jan. 1924, *Bro. Claude-Joseph 2929* (US).

ARGENTINA: Cordoba, Dec. 1891, *Kuntze* (F); tablelands south of Rafaela, Vallee du Rio Atuel, Prov. Mendoza, Jan.–Feb. 1897, *Wilczek 327* (US); vicinity of General Roca, Rio Negro Valley, 250–360 m. alt., Nov. 1914–Feb. 1915, *Fischer 61* (F, M, US); Prov. Cordoba, March 1925, *Lossen 293* (F); Rio del Vallee, Prov. Catamarca, 610 m. alt., 20 Aug. 1928, *Venturi 6074* (M, US).

**34. M. nuda** (Pursh) Torrey & Gray, Fl. N. Am. 1: 535. 1840; Gray in Mem. Am. Acad [Pl. Fendl.] 4: 47. 1849; in Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] 6: 191. 1850; Porter & Coulter, Fl. Colo. 47. 1874; Coulter in Contr. U. S. Nat. Herb. [Fl. Texas] 2: 119. 1891; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] 16: 150. 1913.

*M. nuda* (Pursh) Torrey & Gray α *subpinnatifida* Ktze. Rev. Gen. 1: 251. 1891.

*M. nuda* (Pursh) Torrey & Gray β *integrifolia* Ktze. *Ibid.*

*M. pumila* (Nutt.) Torrey & Gray var. *Reverchonii* Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 94. 1900.

*Bartonia nuda* Pursh, Fl. Am. Sept. 1: 328, and 2: 749. 1814; Nutt. Gen. 1: 299. 1818; DC. Prodr. 3: 340. 1828; Walp. Rep. 2: 224. 1843; Hook. Lond. Jour. Bot. 6: 227. 1847; Bot. Mag. 90: *pl. 5483.* 1864.

*Torreya nuda* Eaton, Man. Bot. ed. 7. 560. 1836; Watson, Bibl. Index, 390. 1878.

*Touterea nuda* Eaton & Wright ex Watson, Bibl. Index, 390. 1878.

*Hesperaster nudus* (Pursh) Cockerell in Torreya 1: 143. 1901.

*Nuttallia nuda* (Pursh) Greene, Leaflets Bot. Obs. & Crit. 1: 210. 1906.

Perennial from a fusiform root; stems solitary, erect, 3–5 dm. high, white, terete, striate, scabrous with verticillate, glochidiate hairs, branched above; leaves alternate, lanceolate to linear-lanceolate, 5–7 cm. long, interruptedly pinnatifid or sinuate-dentate with broad teeth, lower leaves petiolate, the intermediate leaves sessile, smaller, all leaves scabrous and subcanescent on the upper and lower surfaces; flowers corymbose, terminal, sessile, in clusters of 1–3; calyx-tube cylindrical, attenuated, 12–18 mm. long, densely hirsute-scabrous, not bracteolate; calyx-lobes lanceolate to ovate-lanceolate, long-acuminate, 15 mm. long, persistent and withered, irregularly reflexed in the fruit, yellowish, prominent mid-nerve; petals 10, yellow, lanceolate to obovate-lanceolate, 2–5 cm. long, glabrous, apex acute; stamens numerous, 100–150, in 4 series, 2–4 cm. long, the 5 outer filaments petaloid and often sterile, other filaments filiform; style shorter, 1–2 cm. long, filiform, angled, densely papillose at the apex, persistent and withered in the fruit; capsule cylindrical, 2–3 cm. long, yellow to yellowish-brown, subligneous, striated; seeds 70–80, in 2 series on each placenta, orbicular-ovate, 3–4 mm. in diameter, brownish, densely granulate-punctate, broadly winged.

Distribution: gravelly and open places of Nebraska, south and westward to Oklahoma, Texas, and Colorado.

Specimens examined:

INDEFINITE LOCALITY: *Nuttall* (ANSP TYPE); Rocky Mountains, 1888, *Vasey* (US).

NEBRASKA: Upper Lawrence Fork, 10 Aug. 1891, *Rydberg 123b* (US).

KANSAS: Coolidge, Aug. 1884, *Kellerman* (US); Coolidge, 1892, *Hitchcock* (M); Hamilton Co., 3 July 1893, *Thompson 74* (US).

OKLAHOMA: Cimarron Canyon, Neutral Strip, 1 Aug. 1891, *Carleton 378* (US); near Hollis, Harmon Co., 22 June 1913, *Stevens 1161* (M).

TEXAS: near Dallas, July–Sept., *Reverchon 959b* (ANSP, F, M); Shackelford Co., *Holstein* (ANSP); Valley of Rio Grande, below Donana, *Parry, Bigelow, Wright & Schott 390* (US); indefinite locality, July 1829, *Berlandier 522–590* (ANSP); Upper Arkansas, 21 July 1845, *Fremont's Expedition 243* (M); San Antonio, July 1845, *without collector* (M); "western Texas to El Paso, New Mexico," May–Oct. 1849, *Wright 212* (C, US); Cibold River, Comal Co., July 1849, *Lindheimer 815* (ANSP, C, F, M, US); Callahan Co., May 1882, *Reverchon 322* (F, US); sandy western plains, Marion Co., June 1885, *Reverchon 322* (M); Champion Creek, Aug. 1888, *Havard* (US); Limpia Canyon, 1889, *Nealley 658 (156)* (US); Kerrville, Kerr Co., 19–26 June 1894, 1600–2000 ft. alt., *Heller 1896* (ANSP, US); San Antonio, 1897, *Wilkinson 42* (M); prairies, near Colorado, Mitchell Co., 8 June 1900, *Eggert* (M); same locality, 9–10 June 1900, *Eggert* (M); open ground, Sabinal, Uvalde Co., 7 June 1916, *Palmer 10092* (M); near San Antonio, 1900–1902, *Wilkinson* (M); near Bracken, Comal Co., 29 July 1903, *Groth 140* (F); Bexar Co., 1903 *Jermy* (M, US); Amarillo, 7 Aug. 1903, *Reverchon* (M); Estelline, 25 May 1906, *Reverchon* (M); Spanish Pass, Kendall Co., 5 July 1911, *Clemens & Clemens 540* (CAS, M, P, RM); Bexar Co., 28 June 1919, *Schulz 215* (US); below Eldorado, 2410 m. alt., 14 July 1920, *Eggleston 16706* (F); Garza Co., June 1925, *Ruth 1288* (RM, US).

COLORADO: Huerfano, Aug. 1867, *Parry 81* (M).

### **35. M. strictissima** (Wooton & Standley) Darlington, n. comb.

*Nuttallia strictissima* Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **16**: 150. 1913.

Perennial, 5–7 dm. high; stems strict, simple below, branched above, whitish, scabrous; lower leaves linear-elliptic, acute, scabrous, shallowly dentate, sessile, the upper leaves linear to linear-lanceolate, reduced and bract-like, crowded, mostly entire, attenuated; flowers few, terminal; calyx-lobes narrowly triangular, 10 mm. long, attenuate, thick, scabrous with short, stiff, white hairs; petals 18–22 mm. long, linear-oblanceolate, acute; stamens numerous, filaments of outer series broad and petaloid; capsules 20 mm. long, 8 mm. broad, cylindric, scabrous; seeds small, margined.

Distribution: rare occurrence in New Mexico.

Specimens examined:

NEW MEXICO: 20 miles south of Roswell, Chaves Co., 3600 ft. alt., Aug. 1900, *Earle 317* (M, P, US).

**36. M. multiflora** (Nutt.) Gray in Mem. Am. Acad. [Pl. Fendl.] **4**: 48. 1849; Porter & Coulter, Fl. Colo. 47. 1874; Brewer & Watson, Bot. Calif. **1**: 235. 1876; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 94. 1900; Rydb. Fl. Colo. 234. 1906; Coulter & Nelson, Man. Bot. Rocky Mts. 324. 1909; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 436. 1915; Rydb. Fl. Rocky Mts. & Adj. Plains, ed. 2. 574. 1922;Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 361. 1925; Jepson, Man. Fl. Pl. Calif. 848. 1925.

*M. pumila* O. Ktze. Rev. Gen. **1**: 251. 1891, not *M. pumila* (Nutt.) Torrey & Gray.

*M. pumila* (Nutt.) Torrey & Gray var. *multiflora* (Nutt.) Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 93. 1900.

*M. aurea* Osterh. in Bull. Torr. Bot. Club **28**: 644. 1901, not Nutt.

*M. speciosa* Osterh. *Ibid.* 689. 1901; *Ibid.* **30**: 276. 1903.

*Bartonia pumila* Hook. in Lond. Jour. Bot. **6**: 227. 1847.

*Bartonia multiflora* Nuttall in Proc. Acad. Sci. Phila. **4**: 23. 1848.

*Hesperaster multiflorus* (Nutt.) Cockerell in Torreya **1**: 143. 1901.

*Hesperaster speciosus* Osterh. in Bull. Torr. Bot. Club **29**: 174. 1902.

*Touterea speciosa* (Osterh.) Rydb. *Ibid.* **30**: 276. 1903.

*Touterea multiflora* (Nutt.) Rydb. *Ibid.* 277. 1903.

*Touterea sinuata* Rydb. *Ibid.* **31**: 566. 1904.

*Nuttallia multiflora* (Nutt.) Greene, Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

*Nuttallia speciosa* (Osterh.) Greene, *Ibid.* 1906.

*Nuttallia sinuata* (Rydb.) Daniels, Fl. Boulder, Colo. 173. 1911.

*Nuttallia Springeri* Standl. in Proc. Biol. Soc. Wash. **26**: 115. 1913.

*Nuttallia marginata* Osterh. in Bull. Torr. Bot. Club **49**: 183. 1922.

Perennial from a stout tap-root, 4–8 dm. high; stems smooth or slightly scabrous below, always pubescent towards ends of the branches, corymbosely branched, yellowish-white; leaves narrowly lanceolate, sinuate, deeply pinnatifid, 5–7.5 cm. long, 1–2 cm. broad, scabrous on upper and lower surfaces with short stiff verticillate glochidiate and antrorse spine-like hairs, sessile; flowers corymbose, terminating the branches, 3–4 in a cluster, subtended by 1, rarely 2, linear revolute bracts; calyx-tube urceolate, brownish, attenuated, 15–16 mm. long, scabrous; calyx-lobes long-subulate, yellowish, partially reflexed, persistent; petals 10, oblong-oval, obtuse at the apex, 15–20 cm. long, yellow, the inner petals smaller; stamens numerous, all antheriferous, filaments filiform, with the outer series slightly longer and somewhat broadened; style elongated, filiform; capsule urceolate, 15–20 mm. long, 6–8 mm. broad, 3- or 4-valved, scabrous with short stiff glochidiate and spine-like hairs, brownish; seeds in a double series on succulent placentae, thickish, with winged margins, pale brown.

Distribution: in sandy, open places from Wyoming to California, south to Texas and Mexico.

Specimens examined:

TEXAS: Gila Valley, Los Hetates, *Schott* (F); Gallejo Springs, south of El

Paso, 21 Aug. 1846, *Wislizenus 134* (M); El Paso, 1851, *Wright 1082* (ANSP); El Paso, April 1881, *Vasey* (US); Presidio, 8 May 1881, *Havard* (US); El Paso, 1884, *Jones* (P); El Paso, 23 April 1884, *Jones 3758* (CAS, F, P, RM, US); Amarillo Creek, 29 May 1902, *Reverchon 3103* (M); 25 miles north of Boquilas, 17 April 1919, *Hanson 591* (M).

Wyoming: Chugwater, 30 June 1909, *Cary 348* (US).

Colorado: near Leadville, *Schedin & Schedin* (RM); without definite locality, 1862, *Hall & Harbour 570* (F, M, US); Pike's Peak, 1 Sept. 1878, *Martindale* (ANSP); Ute Pass, above Manitou Springs, 1 Sept. 1881, *Engelmann* (M); Manitou, Aug. 1883, *Fritchey* (M); Larimer Co., 9 July 1884, *Sheldon 20* (US); Pike's Peak Trail, 13 Aug. 1888, *Holway* (US); near Boulder, 5000 ft. alt., 6 July 1892, *Patterson 210* (M); Bear Creek Cañon, 6500 ft. alt., 10 Aug. 1892, *Sheldon 427* (US); Bear Creek Canyon, El Paso Co., 6500 ft. alt., 10 Aug. 1892, *Sheldon 104* (US); pond border, Buena Vista, 8000 ft. alt., Chaffee Co., *Sheldon 425* (US); Silver Cliff, July 1895, *Milligan* (US); Ute Pass, 2 July 1896, *Shear 3692* (US); Cheyenne Canyon, 20 June 1896, *Biltmore Herbarium 1 220* (M, US); Salida, 19 June 1898, *Baker, Earle & Tracy 853* (C, P); Cascade Canyon, 28 July 1900, *Harper* (M); Estes Park, Larimer Co., 18 and 21 July 1900, *Osterhout 2203* (RM, US); Pike's Peak, 1 Sept. 1901, *Nelson 8620* (RM); Mesa, Boulder Co., 5700 ft. alt., 19 June 1906, *Daniels 77* (M); Estes Park, 10 Aug. 1910, *Johnston 743* (RM); Creede, Mineral Co., 1 Aug. 1911, *Murdock 4804* (F, M, P, US); Ruxton Creek, 9500 ft. alt., 4 Aug. 1912, *Brumback & Davies 96* (F); near hospital, Boulder, Boulder Co., 8 June 1913, *Vestal* (M); Naturita, 5400 ft. alt., 21 June 1914, *Payson 332* (F, M, RM); Trinidad, Los Animas Co., 20 July 1918, *Osterhout 5757* (P); Buena Vista, Chaffee Co., 2410 m. alt., 1–2 Aug. 1919, *Eggleston 15400* (F); Divide, Cripple Creek, Teller Co., 2800 m. alt., 2 Aug. 1920, *Clokey 3820* (ANSP, CAS, F, M, P, RM, US); Naturita, western Montrose Co., 5800 ft. alt., 20 June 1924, *Payson & Payson 3862* (M, RM); Pike's Peak, 8800 ft. alt., 14 Aug. 1924, *Bacigalupi 818* (P); Denver, 27 June 1926, *Benke 4165* (F); 6 miles west of Dyke, Archuleta Co., 6450 ft. alt., 29 July 1928, *Wolf 3085* (CAS).

New Mexico: Albuquerque, *Havard* (M); near Galileo, *Bigelow* (US); Albuquerque, 17 July 1846, *Wislizenus 18* (M); Santa Fe, June–July 1847, *Fendler 242* (ANSP, F, M, US); Fort Defiance, 1869, *Palmer* (US); Albuquerque, 5 Sept. 1884, *Jones* (P); Whitewater, Grant Co., 31 May 1892, *Mearns 69* (US); Albuquerque, 1894, *Herrick* (US); Lorenzo's Springs, 18 miles east of Albuquerque, 14 Sept. 1895, *Mulford 1233* (M); hills in Santa Fe Co., 7300 ft. alt., 28 May 1897, *Heller & Heller 3778* (M, P, US); Las Cruces, Dona Ana Co., 3900 ft. alt., 23 June 1897, *Wooton 57* (M, P, RM, US); Gray, Lincoln Co., 6000 ft. alt., 1898, *Skehan 115* (M, US); Patterson, 15 Aug. 1900, *Wooton* (US); dry canyon, 4600 ft. alt., Otero Co., 7 April–24 May 1902, *Rehn & Viereck* (ANSP); Mangas Springs, 19 Aug. 1902, *Wooton* (US); Florita Mts., 5400 ft. alt., 7 Sept. 1903, *Jones* (P); Mimbres River, Black Range, 5500 ft. alt., 1 July 1904, *Metcalfe 1045* (CAS, F, M, P, US); Hondo Canyon, Lincoln Co., 8200 ft. alt., 10 Aug. 1904, *Bailey 888* (US); Turner's Ranch, 19 July 1905, *Wooton* (US); Van Patten's, Organ Mts., 9 June 1906, *Standley* (M); Mesilla Valley, Dona Ana Co., 3850 ft. alt., June 1906, *Wooton & Standley* (US); Mesilla Valley, Dona Ana Co., 3800 ft. alt., 2 Aug. 1907, *Wooton* (UM); Santa Fe, 6 Aug. 1910, *Wooton* (US); Silver City, 1911, *Beard* (M); vicinity of Raton, Colfax Co., 2100–2380 ft. alt., 21–22 June 1911, *Standley*

*6254* (US); vicinity of Raton, 27 Sept. 1913, *Rose & Fitch 17555* (US); Las Huertas Canyon, Allen's Ranch, Sandia Mts., 19 July 1914, *Ellis 170* (US); mesa, 2 miles east of Albuquerque, 5000 ft. alt., 1915, *Kammerer 49* (ANSP, M, US); Lordsburg, 15 May 1919, *Eastwood 8549* (CAS); vicinity of Las Vegas, San Miguel Co., Sept. 1919, *Anect 104* (CAS, US); near Albuquerque, Bernalillo Co., 21 June 1926, *Palmer 31146* (ANSP, M); Sandia Mts., road between Santa Fe and Albuquerque, 16 Oct. 1928, *Eastwood 15641* (CAS); Carlsbad, 27 April 1929, *Benke 5036* (M); near highway, 10 miles west of Deming, 4000 ft. alt., 17 June 1930, *Goodman & Hitchcock 1149* (CAS, M).

UTAH: sandy soil, Moab, 4100 ft. alt., June 1899, *Purpus 6507* (M, US).

ARIZONA: Billie Williams Mts., 24–25 July 1864, *Anderson* (M); without definite locality, 1873, *Low* (F); near Camp Lowell, 16 May 1881, *Pringle* (F, M); Prescott, May 1883, *Rusby 612* (US); Beaver Head, 8 Aug. 1883, *Rusby 613* (F, P, US); Bowie, Sept. 1884, *Jones* (US); Big Bug, 27 July 1891, *Toumey* (US); San Bernardino Ranch, 11 Sept. 1892, *Mearns 827* (US); Niggerhead Mts., near Monument No. 82, 17 Aug. 1893, *Mearns 1945* (US); Tucson, 30 June 1894, *Toumey* (US); Prescott, 4 July 1896, *Kuntze* (US); Tucson, 6 May 1896, *Zuck* (F); Tempe, 18 Aug. 1901, *Kearney 103* (M, US); Santa Rita Mts., 20 Sept.–4 Oct. 1902, *Griffiths & Thornber 192* (US); Tempe, 18–27 May 1903, *Griffiths 4326* (US); vicinity of Yuma, 27 April 1905, *Goldman 1082* (US); ridge west of Chiricahua Mine, Chiricahua Mts., 7000 ft. alt., 10 Nov. 1906, *Blumer 1509* (F, M, US); Paradise, Chiricahua Mts., 6700 ft. alt., 30 July 1907, *Blumer 1609* (F, M, US); sand dune, Hopi Mesa, Aug. 1909, *Saunders* (US); Seligman, 10 Aug. 1911, *Wooton* (US); Parker, 6 March 1913, *Wooton* (US); limestone hill above Portal, Cochise Co., Chiricahua National Forest, 1600–1800 m. alt., 26–29 Sept. 1914, *Eggleston 10962* (US); trail to Dixie Canyon, Bisbee, 24 May 1915, *Carlson* (CAS, US); Seligman, 22 June 1916, *Eastwood 5932* (CAS); Kirkland, 1916, *Taylor 22* (US); Phoenix, 18 April 1917, *Eastwood 6162* (CAS); 4 miles south of Dos Cabezas, Chiricahua Mts., Cochise Co., 2 July 1919, *Stone 463* (ANSP); roadside near Tucson, Pima Co., 4 Jan. 1920, *Bartram 345* (ANSP); near Tucson, 12 Oct. 1925, *Peebles, Harrison & Kearney 440* (US); near Sacaton, 2 May 1926, *Harrison 1781* (US); Patagonia Mts., 28 Aug. 1927, *Peebles & Harrison 4737* (US); Soda Springs, Beaver Creek, 13 miles above Camp Verdi, Yavapai Co., 3600 ft. alt., 30 June 1928, *Wolf 2415* (CAS); Pinal Mts., 13 Oct. 1929, *Harrison & Kearney 6364* (US).

CALIFORNIA: McCoy Wash, 300 ft. alt., Colorado Desert, Riverside Co., April 1905, *Hall 5925* (RM); Kelso, San Bernardino Co., 8 June 1915, *Brandegee* (C); Ford's Well, west of Blythe, 1000 ft. alt., 3 April 1920, *Munz & Harwood 3580* (M, P, RM); 6 miles north of Blythe, Riverside Co., 400 ft. alt., 22 March 1932, *Peirson 9809* (M, PH, UM).

MEXICO: Saltillo, 2 June 1848, *Gregg 102* (M); San Lorenzo de Laguna, 75 miles southwest of Parras, State of Coahuila, 1–10 May 1880, *Palmer 358* (ANSP); St. Eulalia plains, Chihuahua, 7 Sept. 1885, *Wilkinson* (US); valley near Chihuahua, 30 Aug. 1886, *Pringle 737* (ANSP, F, M, US); Hermosillo, Sonora, 10 June 1897, *Maltby 224* (US); Torreon, Coahuila, 13–20 Oct. 1898, *Palmer 480* (M); near Casas Grandes, State of Chihuahua, 30 Aug. 1899, *Nelson 6323* (US); Casas Grandes, Chihuahua, 2 June 1899, *Goldman 431* (US); plains at Montezuma Station, Chihuahua, 5000 ft. alt., 27 Sept. 1902, *Pringle 9803* (F, M, US); Colonia

Juarez, Sierre Madre Mts., Chihuahua, 5200 ft. alt., 11 Sept. 1903, *Jones* (P); vicinity of Aldamia, Chihuahua, 15–17 May 1908, *Palmer 248* (F, M, US); vicinity of Magdalena, Sonora, 25 April 1910, *Rose, Standley & Russell 15085* (US); Arroyo de Las Alamos, El Alamo near Magdalena, Sonora, 17 May 1925, *Kennedy 7092* (CAS, M, US); El Alamo Ranch, Magdalena, 25 May 1925, *Kennedy* (CAS).

37. **M. pumila** (Nutt.) Torrey & Gray, Fl. N. Am. **1**: 535. 1840; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 93. 1900; Rydb. Fl. Colo. 234. 1906; Coulter & Nelson, Man. Bot. Rocky Mts. 324. 1909; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. New Mex.] **19**: 436. 1915; Rydb. Fl. Rocky Mts. & Adj. Plains, ed. 2. 574. 1922; Davidson & Moxley, Fl. South. Calif. 239. 1923; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 361. 1925.

*M. Wrightii* Porter & Coulter, Fl. Colo. 47. 1874.

*M. multiflora* (Nutt.) Gray var. Parry in Am. Nat. **9**: 271. 1895.

*M. pumila* (Nutt.) Torr. & Gray, var. *genuina* Urb. & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 93. 1900.

*Bartonia pumila* Nutt. Gen. N. Am. **1**: 299. 1818.

*Hesperaster pumilus* (Torr. & Gray) Cockerell in Torreya **1**: 143. 1901.

*Touterea pumila* (Nutt.) Rydb. in Bull. Torr. Bot. Club **30**: 277. 1903.

*Nuttallia pumila* (Nutt.) Greene, Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

Biennial from a fusiform root; stems tortuous, grayish or yellowish-white, striate, low and stout, most branched toward the summit, pubescent with glochidiate and spine-like hairs; leaves alternate, obovate-lanceolate to linear-lanceolate, 3–10 cm. long, irregularly sinuate-dentate to sinuate-pinnatifid, acute or obtuse at the apex, upper and lower surfaces scabrous with short verticillate glochidiate hairs, lower leaves somewhat petioled, the intermediate leaves sessile with subcordate semi-amplexicaul base; flowers cymose, terminating branches, in clusters of 1–3, small, slightly pedicellate, subtended at base of calyx-tube by 1–2 linear setaceous bracts; calyx-tube subcylindrical or clavate, 5–15 mm. long, attenuated, hirsute, scabrous; calyx-lobes ovate-oblong, long-acuminate, lanceolate to linear-lanceolate, yellowish, persistent and withered in fruit, reflexed; petals 10, yellow, obovate to lanceolate, unguiculate, acute or obtuse at the apex, 9–15 mm. long, apex sparsely pilose, otherwise glabrous; filaments 60–120, in 3 to 4 series, outer series broadened and longer, the other series linear; style filiform, angled, persistent in fruit, apex papillose; capsule subcylindrical, oblong or clavate, attenuate, obtuse or rotund at the base, 15–20 mm. long, brownish-yellow to brownish-black, scabrous, striate; seeds in 2, rarely 1, rows, mottled brown, minutely punctate-granulate, broadly winged.

Distribution: prairies and slopes, Wyoming and Utah, south to Texas and Arizona.

Specimens examined:

INDEFINITE LOCALITY: Ham's Fork of the Colorado of the West, *Nuttall* (ANSP TYPE).

TEXAS: flats north of Van Horn, El Paso Co., 9 July 1900, *Eggert* (M); prairies north of Sierra Blanca, El Paso Co., 12 July 1900, *Eggert* (M); flats north of Van Horn, El Paso Co., 13 May 1901, *Eggert* (M).

COLORADO: Montrose, 21 July 1897, *Shear 4810* (US).

NEW MEXICO: indefinite locality, 1851, *Wright 1082* (US); arroyo south of San Marcial, Socorro Co., 22 June 1921, *Ferris & Duncan 2338* (CAS, M).

UTAH: indefinite locality, *Ward* (ANSP); near Glenwood, 5000 ft. alt., 4 June 1875, *Ward 164* (ANSP, M, US); Green River, 21 June 1879, *Jones* (P); sands near Green River, 4500 ft. alt., 12 June 1901, *Stokes* (US).

ARIZONA: indefinite locality, *Voth 17* (F); 12 miles below Black Falls, Little Colorado, 15 May 1901, *Ward* (US); Yuma, 25 April 1906, *Jones* (P); top of Sunset Mountain, Coconino National Forest and vicinity, 8000 ft. alt., 25 Aug. 1908, *Pearson 39* (US); Flagstaff, 7000 ft. alt., 31 Aug. 1923, *Hanson & Hanson 932* (M); slope of Sunset Mountain, 4 July 1923, *Hanson & Hanson 616* (M, RM).

WYOMING: dry places, North Fork Wind River, 16 July 1882, *Forwood* (US); Big Wind River, 5 Aug. 1894, *Nelson 3989* (RM).

**37a. M. pumila** (Nutt.) Torrey & Gray var. **procera** (Wooton & Standley) Darlington, n. comb.

*Nuttallia procera* Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. New Mex.] **16**: 150. 1913.

Perennial, slender, 6–10 dm. high; stems strict, sometimes branching at the base, white, the epidermis papery, smooth except on young stems; leaves small, sessile, oblong, obtuse, 3–5 cm. long, about 0.5 cm. broad, with 5–10 coarse rounded teeth on each side, scabrous with short stout white barbed hairs; flowers small on slender terminal peduncles; calyx-lobes narrowly lanceolate, abruptly acuminate; petals bright yellow, oblanceolate, acute, 1 cm. long; outer series of filaments petaloid, narrower than the petals, short-acuminate; capsule oblong-cylindric, 10–12 mm. long, 6–7 mm. in diameter; seeds numerous, disk-shaped, white, tuberculate, surrounded by a broad white wing.

Distribution: Utah and Nevada, south to western Texas and northern Mexico.

Specimens examined:

TEXAS: Frenton, April 1852, *Parry* (M); Cibold Creek, July 1852, *Parry* (M); El Paso, 25 June 1891, *Evans* (M); Altura Park, Franklin Mts., 10 July 1911, *Barlow* (F); Canutillo, Franklin Mts., 21 July 1911, *Barlow* (F); El Paso, 4 Aug. 1920, *Schulz 227* (US); 4 miles west of Sierra Blanca, Hudspeth Co., 4 July 1921, *Ferris & Duncan 2482* (CAS); Indian Hot Springs, 30 April 1930, *Jones 25662* (M); mesa, north of Chisos Mts., Brewster Co., 1370 m. alt., 27 June 1931, *Moore & Steyermark 3275* (M).

NEW MEXICO: Bloomfield, San Juan Co., *Waring 26* (ANSP); White Sands, Dona Ana Co., 3600 ft. alt., 21 June 1895, *Wooton* (US); White Mts., Lincoln Co., 24 Aug. 1897, *Wooton 567* (M, US); White Sands, Dona Ana Co., 4000 ft. alt., 17 July 1897, *Wooton 571* (US); Albuquerque, 1900, *Harward 20* (M, US); White Sands, Otero Co., 20 July 1901, *Wooton* (US); Lake Valley, 28 Aug. 1903, *Diehl 685* (P); Lake Valley, 28 Aug. 1903, *Diehl 680* (P); White Sands, Otero Co., 31 Aug. 1904, *Wooton* (US); Mesilla Valley, Dona Ana Co., 3800 ft. alt., 2 Aug. 1907, *Wooton* (US); Navajo Indian Reservation, vicinity of Shiprock Agency, 1425 m. alt., 25 July 1911, *Standley 7272* (US); mesa, at Huecos, 25 Aug. 1911, *Barlow* (F); plains southeast of Carlsbad, 12–20 Aug. 1924, *Standley 40331* (US); 27 miles south of Animas, Animas Valley, Hidalgo Co., 4640 ft. alt., July 1928, *Wolf 2588* (CAS).

UTAH: Sierra La Sal, May–Oct. 1900, *Purpus 8091* (C, M, US).

NEVADA: washes, Pioche, 3000–4000 ft. alt., May–Oct. 1898, *Purpus 6269* (US); Pioche, Aug. 31, 1912, *Jones* (P).

ARIZONA: Little Colorado, 9 June 1890, *Jones* (P); St. Joe, 20 July 1892, *Wooton* (US); Piny Creek, Chiricahua Mts., Aug. 1896, *Fernow* (US); Holbrook, 28 June 1896, *Zuck* (F, M); Holbrook, 31 July 1896, *Zuck* (US); indefinite locality, Aug.-Sept. 1896, *Hough 19* (US); Flagstaff, May-Oct. 1900, *Purpus 8071* (C); near Walnut Canyon on slopes, 1700 m. alt., 1 Aug. 1901, *Leiberg 5798* (US); Adamana to Navajo, 12 Sept.–18 Oct. 1903, *Griffiths 5792* (M, US); Adamana to "Long H" Ranch, 6–15 Aug. 1903, *Griffiths 5170* (US); Yuma, 6 Nov. 1909, *Mowry* (US); Adamana, 27 June 1913, *Hitchcock 16½* (US); Adamana, 27 June 1913, *Hitchcock 9* (US); Yuma, 21 April 1913, *Wooton* (US); 3 miles north of Fort Whipple, 5000 ft. alt., 9 July 1916, *Taylor 44* (US); Yuma, 22 April 1917, *Eastwood 6327* (CAS); Yuma, 22 April 1917, *Eastwood 6344* (CAS); Winona, 6400 ft. alt., 16 July 1917, *Goldman 2857* (US); Yuma, 10 April 1922, *McQuarrie* (CAS); near Cameron, 5000 ft. alt., 29 July 1922, *Hanson A149* (M, P); between Jacob's Pool and Horserock, 13 July 1926, *Jaeger* (P); near Yuma, 10 Oct. 1927, *Peebles, Harrison & Kearney 4955* (US).

MEXICO: San Lorenzo, States of Coahuila and Nuevo Leon, Feb.–Oct. 1880, *Palmer 359* (F, US); near Saltillo, State of Coahuila, 5300 ft. alt., 15–30 April 1898, *Palmer 45* (C, F, M, US); Cerro de Cypriano, Coahuila, June 1910, *Purpus 4535* (F, M, US).

38. **M. chrysantha** Engelm. ex Brandegee in Bull. U. S. Geol. Surv. Terr. [Fl. Southwest. Colo.] **2**: 237. 1876; Rydb. Fl. Colo. 235. 1906. Coulter & Nelson, Man. Bot. Rocky Mts. 325. 1909; Rydb. Fl. Rocky Mts. & Adj. Plains, ed. 2. 572. 1922.

*Hesperaster chrysanthus* (Engelm.) Cockerell in Torreya **1**: 143. 1901.

*Touterea chrysantha* (Engelm.) Rydb. in Bull. Torr. Bot. Club **30**: 277. 1903.

*Nuttallia chrysantha* Greene, Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

Biennial; stems 3–6 dm. high, branched, decumbent toward base, mostly smooth; leaves ovate-lanceolate, 2–7 cm. long, sinuate-dentate, lower leaves narrowed toward the base, upper ones sessile, often entire; flowers subsessile, subtended by bracts; petals 10, 15–20 mm. long, the inner 5 petals smaller and often antheriferous; capsule 2.5–3 cm. long; seeds narrowly margined but not winged, surface rough.

Distribution: southern Wyoming and Colorado, probably also in Utah.

Specimens examined:

WYOMING: Laramie, 10 Aug. 1895, *Nelson 1662* (C, RM); Laramie, 19 July 1900, *Nelson 7634* (M, P, RM, US); near Jelm, 12 Aug. 1900, *Nelson 8066* (RM); near Pine Bluffs, 12 Aug. 1917, *Nelson 9798* (M).

COLORADO: Canyon City, 15 Sept. 1873, *Brandegee 842* (M); Fremont Co., 1874, *Brandegee* (M); limestone hills at Canyon City, 26 Sept. 1874, *Engelmann* (M); Canyon City, Oct. 1875, *Brandegee* (M); Ute Pass, Manitou Springs, 3 Sept. 1881, *Engelmann* (M); Pike's Peak, 1890, *Carleton* (F); Manitou, 16 Aug. 1901, *Clements 37* (M, RM, US); north of Florence, Fremont Co., 1 Sept. 1921, *Clokey 4214* (ANSP, CAS, F, M, P, RM, US).

39. **M. Rusbyi** Wooton in Bull. Torr. Bot. Club **25**: 261. 1898; Wooton & Standley in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 434. 1915.

*M. pumila* (Nutt.) Torrey & Gray var. *Rusbyi* Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 358. 1900.

*Hesperaster Rusbyi* (Wooton) Cockerell in Torreya 1: 143. 1901.

*Touterea Rusbyi* (Wooton) Rydb. in Bull. Torr. Bot. Club 30: 276. 1903.

*Nuttallia Rusbyi* (Wooton) Rydb. *Ibid.* 40: 61. 1913.

*Nuttallia hastata* Osterh. *Ibid.* 46: 53. 1919.

Biennial, 8–15 dm. high, branched above; stems erect, stout, scabrous, later becoming glabrous, yellowish-white; lower leaves long, linear-lanceolate, 10–20 cm. long, 1.5–2 cm. broad, attenuated into a petiole, the supper leaves oblong-lanceolate, 4–10 cm. long, sessile, acuminate, sinuate-dentate with a few large sharp teeth, the upper and lower surfaces of leaves rough with barbed hairs; flowers in terminal crowded cymes; calyx-tube clavate, 8–10 mm. long, subtended by two pinnatifid bracts at its base; calyx-lobes narrowly lanceolate, acuminate, 10–12 mm. long; petals 10, light yellow, the outer five narrowly obovate to oblanceolate, acute, 16–20 mm. long, the inner five petals narrower and shorter, often bearing rudimentary anthers at the apex; stamens numerous, 6–12 mm. long, few of the outer filaments slightly dilated; style 1 cm. long, 3-cleft at apex; capsule clavate-cylindric, 3 cm. long, 1 cm. in diameter, striated, scabrous, dark brown; seeds numerous, flattened, ovate, winged.

Distribution: moist slopes of Wyoming southward to New Mexico and Arizona.

Specimens examined:

WYOMING: Cummins, 28–29 July 1895, *Nelson 1470* (M, P, RM, US).

COLORADO: Salida, 14 June 1870, *Bodin* (RM); indefinite locality, Sept. 1875, *Brandegee 1243* (C, M); Middle Park, 27 July 1875, *Patterson* (F); Le Late, Aug. 1875, *Brandegee 1282* (M); Hot Springs Canyon, 12 Sept. 1881, *Engelmann* (M); Dixon Canyon, 31 May 1890, *Crandall 138* (US); Wagon Wheel Gap, Aug. 1890, *Smith* (ANSP); Durango, July 1890, *Eastwood* (CAS); Durango, 1 Aug. 1896, *Tweedy 590* (US); Durango, 18–25 July 1898, *Baker, Earle & Tracy 482* (C, CAS, F, M, P, RM, US); Arboles, June 1899, *Baker 471* (M, P, RM, US); North Park, 6 Sept. 1900, *Osterhout 2268* (P, US); Wolcott, Eagle Co., 21 June 1900, *Osterhout 2110* (RM, US); Jelm, Albany Co., 12 Aug. 1900, *Nelson 8069* (M, P, RM, US); Black Canyon, 8 July 1901, *Baker 370* (M, P, US); Wolcott, 11 July 1902, *Osterhout 2664* (P, RM); near Bayfield, 12 Aug. 1904, *Wooton* (US); near Floressant, 1–8 Aug. 1905, *Ramaley 1397* (RM); Wagon Wheel Gap, 30 July 1911, *Murdock 4771* (CAS, F, M, P, US); Iron Springs, Mesa, 21 Aug. 1912, *Walker 525* (RM, US); Colton, 14 Aug. 1915, *Drushel* (M); Placerville, 23 July

1917, *Payson 1094* (M, RM); Walden, 6 Aug. 1918, *Osterhout 5796* (P, RM); Piedra, Sept. 1924, *Schmoll 1488* (RM); near Dyke, 29 July 1928, *Wolf 3084* (CAS); between Trinidad and Morley, 29 July 1929, *Mathias 489* (M).

NEW MEXICO: Near Moro River, 17 Aug. 1847, *Fendler 243* (M); Gilmore's Ranch, White Mts., 14 July 1895, *Wooton* (US); White Mts., Lincoln Co., 6300 ft. alt., 25 July 1897, *Wooton 210* (M, P, RM, US TYPE); Mogollon Mts., Socorro Co., 5 Aug. 1900, *Wooton* (US); Sacramento Mts., Fresmal, Otero Co., 27 Aug. 1901, *Wooton* (P, RM, US); Mogollon Mts., 9 Aug. 1903, *Metcalfe 450* (M, P, RM, US); Farmington, 8 Aug. 1904, *Wooton* (US); White Mts., Lincoln Co., 21 July 1905, *Wooton* (US); Wheeler's Ranch, 11 July 1906, *Wooton* (US); White Mts., Lincoln Co., 25 Aug. 1907, *Wooton & Standley 3445* (US); Pecos National Forest, 19 July 1908, *Standley 4400* (US); Mora, 11 Aug. 1910, *Wooton* (US); near Dulce, 19 Aug. 1911, *Standley 8094* (US); Vermejo Park, Colfax Co., 31 Aug. 1913, *Wooton* (US); near Ute Park, Colfax Co., 27 Aug. 1916, *Standley 13906* (US).

ARIZONA: Bellemont, 2 Sept. 1883, *Rusby 614* (ANSP); Walker Lake, San Francisco Mts., 17 Sept. 1889, *Knowlton 286* (US); Nagle's Ranch, 17–18 Sept. 1894, *Jones 6054* (M, P, US); east of San Francisco Peaks, 1 Aug. 1901, *Leiberg 5806* (US); Flagstaff to Mogollon Mts., 8–25 July 1903, *Griffiths 4964* (US); Flagstaff, 4 Aug. 1922, *Hanson 150* (F, M); Coconino Plateau, 29 July 1926, *Taylor* (CAS).

### 40. **M. laciniata** (Rydb.) Darlington, n. comb.

*Touterea laciniata* Rydb. in Bull. Torr. Bot. Club **31**: 565. 1904.

*Nuttallia laciniata* (Rydb.) Wooton & Standley in Contr. U. S. Nat. Herb. **16**: 150. 1913.

Biennial or perennial, 3–4 dm. high; stems strict, white, puberulent, branched above; leaves narrowly lanceolate, 5–12 cm. long, deeply pinnatifid to near the midrib, the sinuses rounded or semi-rhombic, lobes oblong to lanceolate, obtuse; flowers terminal, subtended by 1–2 laciniate bracts; calyx-lobes 10 mm. long, lanceolate, apex subulate, soon reflexed; petals golden-yellow, oblanceolate, 15–20 mm. long, base narrowed, apex acute; outer series of stamens petaloid, the other filaments filiform and three-fourths the length of petals; capsule urceolate, 15–20 mm. long, 6–8 mm. broad, scabrous with short, glochidiate and spine-like hairs, brownish; seeds thickish, with winged margins, pale brown.

Distribution: dry hillsides of Colorado and New Mexico.

Specimens examined:

COLORADO: Antonito, 19 July 1898, *Earle 19* (M); Durango, 18 July 1898, *Baker, Earle & Tracy 496* (F, M, P, US); Pagosa Springs, 7000 ft. alt., July 1899, *Baker 470* (F, M, P, RM, US); San Acacio, Costilla Co., 7737 ft. alt., 15 July 1912, *War-*

*ren 36* (RM); Divide, Cripple Creek, Teller Co., 2800 ft. alt., 2 Aug. 1920, *Clokey 3820* (UM); Ridgway, Ouray Co., 7500 ft. alt., 20 Aug. 1920, *Payson & Payson 2309* (CAS, M, RM); Ridgway, Ouray Co., 17 June 1924, *Payson & Payson 3831* (M, RM).

NEW MEXICO: Gallup, 10 June 1916, *Eastwood 5633* (CAS); 8 miles south of Conjilon, Rio Arriba Co., 6630 ft. alt., 24 July 1928, *Wolf 2908* (CAS).

**41. M. pterosperma** Eastw. in Proc. Cal. Acad. Sci. II. 6: 290. 1896; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 356–357. 1900.

*Touterea pterosperma* (Eastw.) Rydb. in Bull. Torr. Bot. Club 30: 276. 1903.

*Nuttallia pterosperma* (Eastw.) Greene, Leaflets Bot. Obs. & Crit. 1: 210. 1906.

Annual, from a fusiform root, 1–2 dm. high, divaricately branched; stems erect, white, shreddy, covered with barbed hairs; lower leaves petiolate, spathulate, often orbicular, 15–20 cm. long, sinuate-dentate, rarely entire, upper leaves sessile, broad at base, 3 cm. long, 2 cm. wide, not uniform in shape or size; flowers at ends of branches, pedicelled, bracted; calyx-tube campanulate, attenuate, about 6 mm. long, 4 mm. broad, densely pubescent; calyx-lobes triangular, acuminate, 6 mm. long, pubescent on outer surfaces, almost glabrous on inner surface; petals lanceolate, 15 mm. long, 4 mm. wide, obtuse; filaments 30–40, in 2 or 3 series, interior filiform, outer series petaloid, anthers minutely scabrous; style filiform, glabrous, angled; capsule campanulate-cylindrical, rotund at base, 10–15 mm. long, 7–8 mm. broad, splitting irregularly; seeds 4 mm. in diameter, in 2 series, oval-rotund, winged with broad circular wings, yellowish-white, covered with minute white dots.

Distribution: mesas in Colorado and Utah.

Specimens examined:

COLORADO: dry mesas, Hotchkiss, 30 June 1892, *Cowen* (US); Grand Junction, May 1892, *Eastwood* (CAS); Gunnison Mesa, Grand Junction, 15 May 1916, *Eastwood 5092* (CAS).

UTAH: 1872, *Bishop* (US); Moab, 26 May 1892, *Eastwood* (CAS); Willows Creek, San Juan Co., 14 July 1895, *Eastwood 31* (CAS TYPE); Green River, 26 June 1899, *Jones* (P).

**42. M. integra** (Jones) Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah and Nev.] 25: 362. 1925.

*M. multiflora* (Nutt.) Gray var. *integra* Jones in Proc. Cal. Acad. Sci. II. 5: 689. 1895.

*Touterea integra* Rydb. Fl. Colo. 235. 1906.

*Nuttallia integra* (Jones) Rydb. in Bull. Torr. Bot. Club 40: 61. 1913.

*Nuttallia lobata* Rydb. *Ibid.*

Perennial from a thick root, 3–4 dm. high; stems strict, pubescent, later becoming almost entirely glabrous, shining white; leaves 5–8 cm. long, oblanceolate to ovate-lanceolate above, mostly entire, rarely simply toothed or triangularly lobed; flowers terminal, subtended by narrowly linear bracts; calyx-lobes lanceolate, acuminate, 8–10 mm. long; petals golden-yellow, spathulate, obtuse, 12–18 mm. long; petaloid staminodia similar and almost equal in size to the petals; filaments numerous in several series, outer series dilated; capsule 15 mm. long, 8–9 mm. broad, acute, turbinate base; seeds large, orbicular, broadly winged.

Distribution: dry hills and mesas, from southern Utah to northern Arizona and northwestern New Mexico.

Specimens examined:

UTAH: near St. George, 1874, *Parry 76* (ANSP, F, M); St. George, 13 May 1902, *Goodding 776* (M); Leeds, 1020 m. alt., 9 May 1919, *Tidestrom 9386* (M, US).

ARIZONA: Virgin River, 2000–3000 ft. alt., May–Oct. 1898, *Purpus 6192* (M, US).

### 43. **M. oreophila** Darlington, n. sp.[36]

Perennial, 2–3 dm. high; stems branched, white, finely pubescent; leaves lanceolate below to ovate-lanceolate above, attenuated below, acuminate at the apex, 3–6 cm. long, coarsely dentate, scabrous, light green, canescent; flowers few, at the ends of the branches, yellow, subtended by entire lanceolate bracts; calyx-lobes ovate, acuminate, yellow, reflexed on the fruit; petals obovate, obtuse, 10–12 mm. long; outer filaments petaloid, inner filaments linear; capsule turbinate, 8–10 mm. long, shortly pedicellate, brownish-black, hirsute-scabrous; seeds broadly winged, light brown, punctate.

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[36] **M. oreophila** Darlington, sp. nov. Planta perennis, 2–3 dm. alta; caulibus ramosis, albis, minute pubescentibus; foliis inferioribus lanceolatis, superioribus ovato-lanceolatis, 3–6 cm. longis, ad basem attenuatis, ad apicem acuminatis, grosse dentatis, scabris, pallide viridibus, canescentibus; floribus paucis ad terminos ramorum, flavis, bracteis integris lanceolatis subtentis; calycis lobis ovatis, acuminatis, flavis, in fructu reflexis; petalis obovatis, obtusis, 10–12 mm. longis; filamentis exterioribus petaloideis, interioribus linearibus; capsula turbinata, 8–10 mm. longa, breve pedicellata, brunneo-nigra, hirsuto-scabra; seminibus late alatis, pallide brunneis, punctatis.—Argus Mts., California, 5000 ft. alt., 11 May 1897, *Jones* (M TYPE).

Distribution: mountainous regions of Inyo County, California.

Specimens examined:

CALIFORNIA: Argus Mts., 5000 ft. alt., 11 May 1897, *Jones* (M TYPE).

**44. M. longiloba** Darlington, n. sp.[37]

Perennial from a stout root, 1–2 dm. high; stems and branches white or yellowish, scabrous at first, later becoming almost glabrous, exfoliating below; leaves few, sessile, long-attenuated below, lanceolate to ovate-lanceolate, 2–6 cm. long, upper leaves smaller, irregularly sinuate-dentate, scabrous; flowers at the ends of the branches, subtended by linear bracts; calyx-lobes ovate-lanceolate, 9–11 mm. long, persistent and reflexed on the fruit; petals yellow, 10–12 mm. long, narrowly obovate; stamens numerous, outer series of filaments dilated, the inner filaments linear; capsule oblong-rotund, 8–10 mm. long, pedicellate, hirsute-scabrous, pale yellowish or nearly white at maturity; seeds numerous, broadly winged, minutely punctate.

Distribution: Utah and California.

Specimens examined:

UTAH: Moab, 30 Aug. 1891, *Jones* (P).

CALIFORNIA: "Hayfields," 15 Sept. 1931, *Jones* (M TYPE); north Fork of Hanaupah Canyon, Panamint Mts., 6000 ft. alt., 7 May 1932, *Peirson 00* (M, PH);

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[37] **M. longiloba** Darlington, sp. nov. Planta perennis, radice crassa, 1–2 dm. alta; caulibus et ramis albis vel flavis, primo scabris, deinde paene glabris, ad basem exfoliantibus; foliis paucis, sessilibus, inferioribus longe attenuatis, lanceolatis vel ovato-lanceolatis, 2–6 cm. longis, superioribus parvioribus, inaequaliter sinuato-dentatis, scabris; floribus ad terminos ramorum, bracteis linearibus subtentis; calycis lobis ovato-lanceolatis, 9–11 mm. longis, in fructu persistentibus reflexisque; petalis flavis, 10–12 mm. longis, anguste obovatis; staminibus numerosis, filamentis exterioribus dilatatis, interioribus linearibus; capsula oblongo-rotundata, 8–10 mm. longa, pedicellata, hirsuto-scabra, ad maturitatem pallide flava aut paene alba; seminibus numerosis, late alatis, minute punctatis.—"Hayfields," California, 15 Sept. 1931, *Jones* (M TYPE).

2 miles east of Darwin, Inyo Co., 4500 ft. alt., 6 May 1932, *Peirson 9894* (M, PH, UM).

**45. M. puberula** Darlington, n. sp.[38]

Perennial, 1.5 dm. high; stems and branches somewhat decumbent, white, scabrous, long ovate-lanceolate; leaves 3–5 cm. long, coarsely dentate; flowers yellow, at the ends of the branches, subtended by one linear bract; calyx-lobes persistent, revolute, lanceolate, 6–8 mm. long; petals narrowly obovate, 8–10 mm. long, apex obtuse, base unguiculate; outer stamens petaloid, inner filaments linear; capsule turbinate, 9–10 mm. long, pedicellate, scabrous; seeds light brown, broadly winged, slightly punctate.

Distribution: southern California and adjacent Arizona.

Specimens examined:

CALIFORNIA: Kane Springs, Ord Mts., San Bernardino Co., 1 May 1906, *Hall & Chandler 6824* (C TYPE, M photograph).

ARIZONA: Gila Mts., Yuma Co., 28 March 1932, *Harrison & Kearney 8410* (M, US).

**46. M. lutea** Greene in Pittonia **3**: 99. 1896.

*Touterea lutea* (Greene) Rydb. Fl. Colo. 235. 1906.

*Nuttallia lutea* Greene, Leaflets Bot. Obs. & Crit. **1**: 210. 1906.

Biennial, from a slender fusiform fleshy root; stems 4–6 dm. high, branched above; basal leaves thickened, sinuate-pinnatifid, upper leaves large, sinuate-dentate; flowers small, deep greenish-yellow; petals 10, acute, elliptical, narrowed at base into a ligulate claw, the inner petals shorter than the outer, stamens numerous, style exceeding the stamens; capsule thick-walled, not striate; seeds oval, flattened, irregularly angled, with a thin winged margin.

Distribution: alkaline soil near Canyon City, Colorado.

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[38] **M. puberula** Darlington, sp. nov. Planta perennis, 1.5 dm. alta; caulibus et ramis decumbentibus, albis, scabris, longo-ovato-lanceolatis; foliis 3–5 cm. longis, grosse dentatis; floribus flavis ad terminos ramorum, uno bracteo lineare subtentis; calycis lobis persistentibus, revolutis, lanceolatis, 6–8 mm. longis; petalis anguste obovatis, 8–10 mm. longis, apice obtusis, base unguiculatis; staminibus exterioribus petaloideis, interioribus linearibus; capsula turbinata, 9–10 mm. longa, pedicellata, scabra; seminibus pallide brunneis, late alatis, paulo punctatis.—Kane Springs, Ord Mts., San Bernardino Co., California, 1 May 1906, *Hall & Chandler 6824* (C TYPE, M photograph).

Specimens examined:

NOTE: No authentic specimens of this species have been seen. However, due to the unusual color of the flowers, it has been maintained as a possible species. Urban and Gilg reduced it to synonymy under *M. pumila* to which it may be found to belong when additional material is available for study.

## SECTION III. TRACHYPHYTUM Torrey & Gray

Section III. TRACHYPHYTUM Torrey & Gray, Fl. N. Am. **1**: 533. 1840; Walpers, Rep. **2**: 224. 1843; Brewer & Watson, Bot. Calif. **1**: 235. 1876; Urban & Gilg in Engl. & Prantl, Nat. Pflanzenfam. **$3^{6a}$**: 110. 1894; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 25. 1900.

Annuals; stems glabrous or pubescent, usually white, rarely yellowish; leaves sessile, sinuate-dentate to pinnatifid, rarely entire; flowers mostly small, in terminal cymes; petals 5, yellow or white, rarely deep yellow with vermillion base; filaments all filiform, or the outer 5 dilated, few to numerous; capsule linear-cylindrical, attenuated, sessile; placentae narrowly filiform; seeds 10–40, in 1 series, pendulous, irregularly angled, somewhat cubical, ovate to subglobose, opaque, minutely tuberculate or muriculate, not winged. Spp. 47–58.

### KEY TO THE SPECIES OF SECTION TRACHYPHYTUM

A. Stems densely scabrous.
  B. Flowers white.
    C. Capsule short and broad, 5–6 mm. long................*50. M. bartonioides*
    CC. Capsule cylindrical, 15–20 mm. long......................*49. M. Solierii*
  BB. Flowers deep yellow.........................................*48. M. citrina*
AA. Stems glabrous or nearly so (except in *52*).
  B. Subtending bracts linear-lanceolate; inflorescence not congested, not entirely concealed by bracts.
    C. Petals 2–15 mm. long.
      D. Capsule narrowly elongated, several times longer than broad.
        E. Seeds irregularly angled, not grooved, or but slightly so on one angle, tuberculate.
          F. Petals generally small, 2–8 mm. long.
            G. Petals 2–4 mm. long; leaves entire or sinuately pinnatifid ..........................................*51. M. albicaulis*
            GG. Petals 5–8 mm. long; all leaves sinuately pinnatifid.
              H. Petals 5–6 mm. long............*51b. M. albicaulis* var. *gracilis*
              HH. Petals 8 mm. long..........*51a. M. albicaulis* var. *ctenophora*
          FF. Petals generally large, 5–15 mm. long.
            G. Petals 8–14 mm. long; calyx-lobes 5 mm. long.

H. Flowers golden-yellow; seeds slightly grooved on one angle ........................................ *52. M. gracilenta*

HH. Flowers copper-colored at the base; seeds not definitely grooved on one angle........ *52b. M. gracilenta* var. *pectinata*

GG. Petals 5–8 mm. long; calyx-lobes 3 mm. long.............. ......................... *52a. M. gracilenta* var. *Veatchiana*

EE. Seeds regularly and sharply angled, grooved on angles, minutely muricate.

F. Leaves mostly ovate-lanceolate, entire or sinuate-pinnatifid; petals 3–6 mm. long.

G. Petals 3–4 mm. long.

H. Stems loosely branched; capsules 15–25 mm. long...... ......................................... *56. M. dispersa*

HH. Stems densely branched; capsules 10–13 mm. long........ ........................... *56b. M. dispersa* var. *compacta*

GG. Petals 5–6 mm. long.............. *56a. M. dispersa* var. *latifolia*

FF. Leaves lanceolate, more or less deeply pinnatifid; petals 6–8 mm. long......................................... *55. M. affinis*

DD. Capsule shortened, nearly as broad as long.

E. Stamens 25–30 in 2 series........................ *47. M. pinnatifida*

EE. Stamens 10–13 in 1 series.......... *47a. M. pinnatifida* var. *uniseriata*

CC. Petals 8–40 mm. long.

D. Petals 20–40 mm. long, golden-yellow with a vermillion base........ ....................................................... *58. M. Lindleyi*

DD. Petals 8–25 mm. long, golden-yellow.

E. Petals 15–25 mm. long.

F. Stamens one-half the length of petals............... *57. M. nitens*

FF. Stamens one-third the length of petals..*57b. M. nitens* var. *eremophila*

EE. Petals 8–12 mm. long.

F. Stems stout, shining-white; upper leaves triangular and mostly entire ............................ *57a. M. nitens* var. *Jonesii*

FF. Stems slender, tenuous, green; upper leaves linear-lanceolate, mostly entire ..................... *57c. M. nitens* var. *leptocaulis*

BB. Subtending bracts ovate-orbicular to ovate-lanceolate; inflorescence congested, more or less concealed by bracts.

C. Stamens filiform; bracts membranaceous.

D. Leaves sinuately toothed or pinnatifid................. *53. M. congesta*

DD. Leaves mostly entire............... *53a. M. congesta* var. *Davidsoniana*

CC. Stamens broadened; bracts leaf-like.................... *54. M. micrantha*

**47. M. pinnatifida** (Phil.) Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 358. 1900.

*M. andina* Urban & Gilg, *l. c.* 31. 1900.

*Acrolasia bartonioides* Gay, Fl. Chile **2**: 429. 1846; Wedd. Chlor. And. **2**: 220. 1857, not Presl.

*Acrolasia pinnatifida* Phil. in Anal. Univ. Chile **85**: 6. 1894.

Annual; stems solitary, erect, branched at base, 6–10 cm. long, striate, yellow to yellowish-white; lower leaves alternate, linear-lanceolate, 4–5 cm. long, sinuate-dentate to sinuate-pinnatifid, base narrowed into a petiole, the intermediate leaves sessile, 2–3 cm. long, linear-lanceolate, sinuate-dentate to sinuate-pinnatifid to subentire, scabrous on both surfaces; flowers at ends of branches; calyx-tube subcylindrical, oblong, 4–6 mm. long, scabrous; calyx-lobes ovate to ovate-oblong, acute at the apex, pilose, yellowish, persistent on the fruit; petals 5, obovate to obovate-rotund, 3–4 mm. long, glabrous; stamens 25–30, in 2 series; filaments filiform, slightly dilated at the base; style persistent on the fruit; capsule oval to oval-oblong, cylindrical, attenuated, 8–9 mm. long, brownish-black, scabrous; seeds 25–30, pendulous, irregularly angled, ovate-globose or polygonal, not winged, grayish-brown, minutely granulate-punctate.

Distribution: Chile.

Specimens examined:

CHILE: Cordilleras de las Patas, Prov. Coquimbo, 3317 m. alt., without date, *Gay 662* (M photograph).

**47a. M. pinnatifida** (Phil.) Urb. & Gilg var. **uniseriata** Haumann in Anal. Soc. Cient. Argent. **86**: 290. 1918.

Stems 30–40 cm. high, branched; basal leaves irregularly dentate, 15 mm. long, sessile; flowers and fruit small; petals 2–5 mm. long, pilose at apex; stamens 12–13 in one series; capsule 10–12 mm. long; seeds 15–20.

Distribution: Valley, Rio Plumo, Argentina.

Specimens examined:

NOTE: Plants more robust than is characteristic of the species. The writer has been unable to study authentic material of this variety.

**48. M. citrina** Urb. & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 27. 1900.

Annual, with solitary erect branched stem, 1–1.5 dm. high, brownish-white, scabrous; leaves alternate, lanceolate to linear-lanceolate, deeply sinuate-dentate to pinnatifid, base narrowed into a petiole, the intermediate leaves sessile, lanceolate to ovate-lanceolate, sinuate-dentate, rarely entire, 5–15 cm. long, upper and lower surfaces scabrous, subcanescent; flowers at ends of branches, sessile; calyx-tube about 7 mm. long, cylindrical, obtuse at base, hirsute; calyx-lobes ovate, 2.5 mm. long, pilose; petals 5, yellow, obovate, 5–6 mm. long, pilose at apex, otherwise glabrous; stamens 20, in 1 series, 3 mm. long, filaments filiform, somewhat dilated at base, glabrous; capsule cylindrical, 1–1.5 cm. long, brownish-black, scabrous, crowned with persistent withered style and calyx-lobes; seeds 15–20, irregularly angled, oblique-subovate or subglobose, brownish, minutely-punctate, not winged.

Distribution: Argentina.

Specimens examined:

ARGENTINA: Punta de la Vaca, Camino de Uspallata, Prov. Mendoza, without date, *Kurtz 3491* (M photograph).

49. **M. Solierii** (Gay) Urban & Gilg in Ber. Deut. Bot. Ges. **10**: 265, *pl. 14, fig. 6*. 1892; in Engl. & Prantl, Nat. Pflanzenfam. **3**$^{6a}$: 110, *fig. 37b*. 1894; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 35. 1900.

*Acrolasia Solierii* Gay, Fl. Chile **2**: 430. 1846.

Annual, with solitary erect branched stems, 1.5–2 dm. high, striate, grayish-white or gray, scabrous; leaves alternate, lanceolate to linear-lanceolate, 3–5 cm. long, entire, rarely sinuate-dentate, base narrowed into a petiole, intermediate leaves sessile with subcordate or subamplexicaul base, mostly entire, rarely sinuate-dentate, scabrous; flowers at apex of branches, sessile; calyx-tube cylindrical to subcylindrical, attenuated, scabrous; calyx-lobes lanceolate or ovate-lanceolate, acute, 2–4 mm. long, pilose, persistent, withered, reflexed or somewhat erect on the fruit, greenish-yellow; petals 5, obovate to obovate-lanceolate, acute at the apex, attenuated or unguiculate at the base, 4–5 mm. long, white, slightly pilose; stamens 15, in 1 series, about 3 mm. long, 5 outer filaments slightly dilated, the remaining filaments filiform; style persistent on the fruit; capsule cylindrical or subcylindrical, obtuse at the base, 1.5–2 cm. long, brownish-green; seeds 15–20, irregularly angled, shortly ovate or subglobose, minutely yellow-punctate, grayish-brown, not winged.

Distribution: Chile and Argentina.

Specimens examined:

CHILE: Los Manantiales, Cordillera del Espinazito, Prov. San Juan, 2770 m. alt., without date, *Stelzner 9755* (M photograph).

50. **M. bartonioides** (Presl) Urban & Gilg in Engl. & Prantl, Nat. Pflanzenfam. $3^{6a}$: 110. 1894; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 26. 1900.

*M. Haenkii* Gray in Smithson. Contr. [Pl. Wright.] **3**: 74. 1852, *in obs.*

*Acrolasia Bartonioides* Presl, Reliq. Haenk. **2**: 39, *pl. 55.* 1835; Walp. Rep. **2**: 223. 1843; **5**: 776. 1845–46.

Annual, with a solitary erect branched stem 1–1.5 dm. high, yellowish, terete, striate; leaves alternate, sessile or nearly so, 1.5–2.5 cm. long, pinnatifid, base subcordate, apex obtuse, the lobes ovate to ovate-oblong with revolute margins, upper and lower surfaces of the leaves scabrous and subcanescent; flowers sessile, at ends of branches; calyx-tube subcylindrical, somewhat attenuated, densely hirsute; calyx-lobes ovate, 2 mm. long, pilose, persistent in the fruit; petals 5, white, obovate, 3 mm. long, apex pilose, otherwise glabrous; stamens 10–15, in one series, 1.5–2 mm. long, slightly dilated at base, glabrous; style filiform, 2 mm. long, glabrous; capsule cylindrical, attenuated, rotund-obtuse at the base, 5–6 mm. long, pale yellow; seeds 10–15, regularly angled, subovate to subglobose, brownish, minutely punctate, not winged.

Distribution: Chile.

Specimens examined:

CHILE: Coquimbo, without date, *Philippi 734* (US).

51. **M. albicaulis** Dougl. ex Hook. Fl. Bor. Am. **1**: 222. [1834] 1840; Gray in Smithson. Contr. [Pl. Wright.] **3**: 74. 1852.

*M. parviflora* Heller in Bull. Torr. Bot. Club **25**: 199. 1898.

*M. tenerrima* Rydb. in Mem. N. Y. Bot. Gard. **1**: 271. 1900.

*M. Tweedyi* Rydb. *Ibid.* 1900.

*Bartonia albicaulis* Dougl. ex Hook. Fl. Bor. Am. **1**: 222. [1834] 1840; Hook. Lond. Jour. Bot. **6**: 227. 1847.

*Bartonia micrantha* Hook. *Ibid.* 1847.

*Acrolasia tenerrima* (Rydb.) Rydb. in Bull. Torr. Bot. Club **30**: 277. 1903.

*Acrolasia Tweedyi* (Rydb.) Rydb. *Ibid.* 1903.
*Acrolasia albicaulis* (Dougl.) Rydb. *Ibid.* 1903.
*Acrolasia viridescens* Heller in Muhlenbergia 2: 98. 1905.
*Acrolasia parviflora* (Heller) Heller, *Ibid.* 1: 138. 1906.

Annual small leafy herbaceous plants 1–4 dm. high, more or less decumbent and branched at base; stems slender, white or greenish-white, shining, sparsely pubescent or puberulent below, smooth above; leaves sessile, scabrous, the lower leaves linear-oblanceolate, 3–5 cm. long, dentate or entire, the middle leaves with several pairs of linear lobes, the upper leaves linear or lanceolate, acute, 2–3 cm. long, less deeply lobed or entire; flowers axillary, sessile, lower solitary, intermediate in pairs, and the terminal ones in corymbose clusters of 3, the two lateral on short branches and subtended by reduced leaves, middle flower naked; calyx-tube cylindrical, 10–15 mm. long, pubescent with long spreading hairs; calyx-lobes lanceolate-subulate, 2–2.5 mm. long, pale greenish-yellow; petals yellow, obovate, spathulate, 2–4 mm. long, spreading, prominently veined, emarginate; stamens shorter than petals, filaments filiform; capsule linear-cylindric, 10–15 mm. long, about 2 mm. in diameter; seeds about 30, in a single series on each placenta, tuberculate-granulate, irregularly cubical or angled.

Distribution: dry or arid sandy soil, slopes or banks, from British Columbia southward to California and New Mexico, westward from western Nebraska to the Pacific Coast.

Specimens examined:

WYOMING: Cummins, 27 July 1895, *Nelson 1455* (US); Badger, Laramie Co., 1 July 1901, *Nelson 8339* (US); Pearson's Ranch, Clark's Fork Valley, 4000 ft. alt., 11 July 1924, *Pearson 70* (RM).

COLORADO: Los Piños, 7000 ft. alt., May 1899, *Baker 467* (US); Black Canyon, Gunnison Watershed, 7000 ft. alt., 20 June 1901, *Baker 203* (US); Paradox, Montrose Co., 17 June 1912, *Walker 109* (US).

NEW MEXICO: between Santa Fe and Cononcito, 7300 ft. alt., 23 June 1897, *Heller & Heller 3750* (US); Gila River Bottoms, near Cliff, Grant Co., 4500 ft. alt., 7 May 1903, *Metcalfe 51* (US); Sandia Mts., Lucero's Ranch, 700 ft. alt., 28 June 1914, *Ellis 250* (US).

IDAHO: Big Butte Station, 23 June 1893, *Palmer 578* (US); St. Anthony, 5 July 1901, *Merrill & Wilcox 840* (US); Spencer, 26 June 1916; *Rust 640* (US).

UTAH: near mouth of Salina Canyon, 5200 ft. alt., 14 June 1894, *Jones 5422C* (US); Asphalt, 5500 ft. alt., 12 July 1894, *Jones 5622* (US); Montezuma

Canyon, east of Monticello, 2000 m. alt., 13 Aug. 1911, *Rydberg & Garrett 9682* (US); canyon, Beaverdam Mts., west of St. George, 1 May 1919, *Tidestrom 9349* (US).

NEVADA: Trinity Mts., 5000 ft. alt., May 1868, *Watson 428* (US); Mica Spring, 4000 ft. alt., 13 April 1894, *Jones 50451* (US); Pyramid Lake, 28 May 1916, *Headly 16* (US); Carey Canyon, Wasatch Mts., 1850 m. alt., 27 June 1919, *Tidestrom 10100* (US).

ARIZONA: Cedar Springs, 6 July 1892, *Toumey 165* (US); Baboquivari Valley, March–April 1903, *Griffiths 3976* (US); Tubac, 13 March 1926, *Loomis 1149* (US); Prescott, 14 May 1927, *Harrison 4008* (US); near Winkelman, 30 March 1928, *Peebles, Harrison & Kearney 5170* (US).

WASHINGTON: Ritzville, Adams Co., 490 m. alt., 6 June 1893, *Sandberg & Leiberg 160* (US); Ellensburg, 20 May 1897, *Piper 2682* (US); Wenatchee Flat, 4 June 1899, *Whited 1122* (US).

OREGON: Swan Lake Valley, Klamath Co., 12 July 1902, *Walpole 2238* (US); north of Terrebonne, 2960 ft. alt., 6 Aug. 1917, *Lawrence 1092* (US); Squaw Creek, Grant Co., April–May 1925, *Henderson 5122* (US).

CALIFORNIA: Bear Valley, San Bernardino Mts., 6500 ft. alt., 19 June 1894, *Parish 3314* (US); base of White Mts., east of Law, Inyo Co., 11 May 1906, *Heller 8232* (US); Lakeside, Eldorado Co., June–July 1912, *Geis 121* (US); Cottonwood Spring, Riverside Co., 2000 ft. alt., 9 March 1920, *Jaeger 918* (US); near Blythe Junction, 1200 ft. alt., 2 April 1920, *Munz & Harwood 3461* (US); 15 miles south of Coachella, Colorado Desert, 12 April 1922, *Peirson 751* (PH); 5–6 miles north of Yermo, San Bernardino Co., 2000 ft. alt., 25 March 1932, *Peirson 9836* (M, PH, UM).

**51a. M. albicaulis** Dougl. var. **ctenophora** (Rydb.) Darlington, n. comb.

*M. ctenophora* Rydb. in Bull. Torr. Bot. Club **28**: 33. 1901.

*Acrolasia ctenophora* Rydb. *Ibid.* **30**: 277. 1903.

Stems 3–6 dm. high, diffuse to branched; lower leaves 1–2 dm. long, pectinately laciniate; calyx-lobes 4–5 mm. long; petals about 8 mm. long.

Distribution: in sandy soil from Montana and British Columbia southward to Nebraska and Arizona.

Specimens examined:

COLORADO: Florence, 7000 ft. alt., 12 June 1895, *Tweedy 104* (US); Cuchara River, below La Veta, 2100 m. alt., 30 May 1900, *Rydberg & Vreeland 5769* (RM TYPE); Evans, 1907, *Johnston* (RM).

OREGON: near Hoover Creek, Gilliam Co., 990 m. alt., 1 June 1894, *Leiberg 136* (C, F, US); Klamath Agency, 30 June 1902, *Walpole 2225* (US).

**51b. M. albicaulis** Dougl. var. **gracilis** (Rydb.) Darlington, n. comb.

*Trachyphytum gracile* Nutt. ex Torrey & Gray, Fl. N. Am. **1**: 534. 1840; Rydb. in Bull. Torr. Bot. Club **31**: 566. 1904, *nomen nudum.*

*Acrolasia gracilis* Rydb. *l. c.*

Plants usually erect; all leaves pinnatifid with many lobes; petals 5–6 mm. long.

Distribution: sandy soil on hillsides and river bottoms from Colorado northwestward to Wyoming, Idaho, and Oregon, south to California and Arizona.

Specimens examined:

WYOMING: Fort Steele, 6500 ft. alt., 10 June 1901, *Tweedy 4573* (US); Chugwater, 30 June 1909, *Cary 345* (US).

COLORADO: Salida, 7500 ft. alt., 19 June 1898, *Baker, Earle & Tracy 14* (US).

IDAHO: Pocatello, 26 May 1893, *Palmer 36* (US); Snake River Bluffs, Fayette, 22 May 1911, *Macbride 865* (US).

UTAH: Milford, 4900 ft. alt., 10–11 May 1903, *Stokes* (US); St. George, April 1880, *Jones* (US).

NEVADA: Vegas Wash, Lincoln Co., 300 m. alt., 12 March 1891, *Coville & Funston 410* (US); Calientes, 24 May 1902, *Goodding 943* (US p. p.).

ARIZONA: Verde Mesa, 1867, *Smart 119* (US); Ash Fort, 18–27 May 1903, *Griffiths 4354* (US); Santan Mts., 22 March 1926, *Peebles, Harrison & Kearney 1239* (US).

WASHINGTON: Wallula, Walla Walla Co., 23 May 1903, *Cotton 1037* (US).

OREGON: between Bear Buttes and Primeville, Crook Co., 1110 m. alt., 25 June 1894, *Leiberg 328* (US); between the Agency and Williamson River Bridge, 23 July 1902, *Coville 1216* (US); north end of Summer Lake, Lake Co., 1360 m. alt., 6 June 1911, *Eggleston 6863* (US).

CALIFORNIA: Furnace Creek Canyon, Funeral Mts., 720 m. alt., 29 Jan. 1891, *Coville & Funston 351* (US); near Campo, San Diego Co., 24 May 1903, *Abrams 3589* (ANSP, M, P, US); vicinity of Doyle Station, Lassen Co., 29 May 1911, *Eggleston 6737* (US); desert, east of Daggett, 28 May 1920, *Munz & Harwood 3649* (US).

**52. M. gracilenta** Torrey & Gray, Fl. N. Am. **1**: 534. 1840; Brewer & Watson, Bot. Calif. **1**: 236. 1876.

*M. albicaulis* Dougl. var. *gracilenta* Watson in U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 115. 1871; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 29. 1900.

*Acrolasia gracilenta* (T. & G.) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

Annual, 1–4 dm. high; stems erect and strict, simple or sparingly branched, green or greenish-white, pubescent; leaves linear-lanceolate to narrowly oblong, sessile, pinnatifid with short obtuse lobes, often entire; flowers clustered at the ends of the branches; calyx-lobes ovate-lanceolate, 4–6 mm. long; petals golden-yellow with an orange base, obovate or oblanceolate, rounded or obtuse at the apex, 8–14 mm. long; stamens numerous, about 40, filaments filiform, subulate; capsule clavate to obconic, 10–20 mm. long; seeds in 3 rows, about 20, prismatic, minutely tuberculate.

Distribution: valleys and slopes from southern Nevada southward through Inyo County to Monterey County, California.

Specimens examined:

California: Atascadero, San Luis Obispo Co., without date, *Brewer 506* (US); near Ranch Jolon, Monterey Co., 7 May 1861, *Brewer 575* (US type); Fort Tejon, Kern Co., 1876, *Kennedy 35* (F); Colton, San Bernardino Co., 29 April 1882, *Jones 3487* (CAS, F, M, US); near Willow Creek, Panamint Mts., Inyo Co., 7 May 1891, *Coville & Funston 748* (US); Erskin Creek, Riverside Co., April–Sept. 1897, *Purpus 5498* (C, M, US); Fremont's Peak, San Benito Co., May 1903, *Elmer 4903* (CAS, M, P, US); Vancouver Pinnacles, San Benito Co., 31 May 1915, *Hall 9961* (US); Aguanga, Riverside Co., 29 April 1922, *Munz 5113* (P).

**52a. M. gracilenta** Torr. & Gray var. **Veatchiana** (Kellogg) Jepson, Man. Fl. Pl. Calif. 652. 1925.

*M. Veatchiana* Kellogg in Proc. Cal. Acad. **2**: 99. 1861.

*M. albicaulis* Dougl. var. *Veatchiana* (Kellogg) Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 28. 1900.

*Acrolasia Veatchiana* (Kellogg) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

Leaves mostly deeply pinnatifid; calyx-lobes about 3 mm. long; petals 5–8 mm. long.

Distribution: mountainous areas from Montana and British Columbia southward to California and Arizona.

Specimens examined:

Colorado: Surface Creek, Delta Co., 6100 ft. alt., June 1892, *Purpus 80* (F); Grand Junction, Gunnison Mesa, 15 May 1916, *Eastwood 5078* (CAS); Morrison, 5800 ft. alt., 22 June 1918, *Clokey & Osterhout 3095* (CAS, M, RM).

Arizona: Clifton, 7 March 1881, *Rusby 138* (C); Ash Fork, May 1883, *Rusby 611* (C); from Chlorida to the River, 13 May 1931, *Eastwood 18310* (CAS, M); Keams Canyon, 14 June 1932, *Harrison 8724* (US).

NEVADA: Virginia City, without date, *Veatch* (CAS TYPE); Quinn River Crossing, July 1901, *Griffiths & Morris 120* (US); Peavine Mountain, Washoe Co., 22 June 1909, *Heller 9763* (ANSP, CAS, F, M, US); west of Carson City, 1800 m. alt., 5 July 1919, *Tidestrom 10260* (P, US); desert between Winnemuca and Elko, 7 June 1930, *Van Dyke* (CAS).

OREGON: Klamath Valley, 4200 ft. alt., 1864, *Cronkhite 46* (C, US); near Alvard Ranch, Harney Co., June–July 1927, *Henderson 8849* (CAS).

CALIFORNIA: Soledad, 29 March 1882, *Jones 3133* (CAS, M, P, US); San Bernardino, 13 May 1882, *Orcutt 102* (US); Byrne's Spring, San Bernardino Mts., 4500 ft. alt., 16 June 1894, *Parish 3312* (M); Mount Pinos Region, Ventura Co., 15 June 1896, *Dudley & Lamb 4508* (P); Santiago Peak, Orange Co., 15 June 1901, *Abrams 1850* (P); near Caliente, Kern Co., 7 April 1905, *Heller 7614* (ANSP, F, M, US); Hunter's Ranch, Inyo Co., 23 May 1906, *Hall & Chandler 7140* (RM); Tehachapi, Kern Co., 13 May 1913, *Eastwood 3236* (CAS, US); Brown's Flat, San Antonio Mts., 4300 ft. alt., 1 July 1917, *Johnston 1755* (P); Loyalton, Sierra Co., 29 June 1918, *Eastwood 7795* (CAS); Barstow, desert, 13 April 1919, *Munz 2555* (P); between Campo and Mountain Springs, San Diego Co., 24 April 1920, *Eastwood 9549* (CAS); Granite Well, Mohave Desert, 14 May 1922, *Johnston 6458* (P); Seymour Creek, Mount Pinos, 6300 ft. alt., 10 June 1923, *Munz 7004* (P); 40 miles west of Mexicalli, 4000 ft. alt., 14 April 1925, *Munz 9596* (P); 35 miles south of Randsburg, Mojave Desert, 5 April 1927, *Craig, Newsom & Hilend 89* (P); Black Canyon, White Mts., 31 May 1930, *Duran 550* (M); 1 mile north of Acton, Los Angeles Co., 12 May 1930, *Howell 4872* (CAS); 2 miles northeast of Lovejoy Buttes, Mohave Desert, Los Angeles Co., 17 April 1932, *Peirson 9862* (M, PH, UM).

The numerously branched stems, the clustered flowers at the ends of the branches, together with stiff stout capsules, make this variety fairly distinct from the species.

**52b. M. gracilenta** Torr. & Gray var. **pectinata** (Kellogg) Jepson, Man. Fl. Pl. Calif. 652. 1925.

*M. pectinata* Kellogg in Proc. Cal. Acad. **3**: 40. 1863.

*M. albicaulis* Dougl. var. *pectinata* (Kellogg) Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 29. 1900.

*Acrolasia pectinata* (Kellogg) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

Leaves mostly pectinately pinnatifid; petals about 10 mm. long, copper-orange at the base; calyx-lobes 5 mm. long; seeds irregularly angled, usually not definitely grooved on one angle as in the species.

Distribution: canyons of southern California.

Specimens examined:

CALIFORNIA: San Bernardino, 1880, *Vasey 209* (F, US); bluffs of Kern River, Kern Co., 8 April 1905, *Heller 7634* (ANSP, F, M, US); Greenhorn Mts., Kern Co., 13 March 1927, *Weston 519* (CAS); Rattlesnake Grade, Greenhorn Mts., Kern Co., April 1927, *Weston 508* (CAS); Stone Canyon, east of Salinas Valley, Monterey Co., 22 March 1931, *Howell 5948* (CAS, M); 2 miles west of Maricopa, Kern Co., 20 March 1931, *Howell 5903* (CAS).

53. **M. congesta** (Nutt.) Torrey & Gray, Fl. N. Am. **1**: 534. 1840; Watson, U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 114. 1871; Brewer & Watson, Bot. Calif. **1**: 236. 1876; Greene, Fl. Francisc. 233. 1891; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 34–35. 1900; Macbride in Contr. Gray Herb. N. S. 56: 28. 1918; Rydberg, Fl. Rocky Mts. & Adj. Plains, ed. 2. 573. 1922; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 364. 1925; Jepson, Man. Fl. Pl. Calif. 650. 1925.

*Trachyphytum congestum* Nutt. ex Torrey & Gray, Fl. N. Am. **1**: 534. 1840.

*Acrolasia congesta* (Torrey & Gray) Rydb. in Bull. Torr. Bot. Club **30**: 277. 1903.

Annual herbaceous plants from a slender tap-root; stems erect, 1–4 dm. high, dichotomously branched, pale yellow or white, sparingly pubescent; leaves alternate, sessile, upper and lower surfaces covered with glochidiate hairs, the margins with longer spine-like hairs, the lower leaves linear-lanceolate, base cordate, somewhat pinnatifid or incisely toothed, 5–7 cm. long, the upper leaves smaller, lanceolate, seldom incised or pinnatifid, clasping at base; flowers congested at the ends of the branches, sessile, yellow, subtended by conspicuous bracts; the bracts 3-lobed or toothed, broadly ovate, 0.6–1.8 cm. long, with the central portion white-membranaceous, the lobes or teeth of the bracts bright green, the margins ciliated, nearly concealing the cluster of 3–5 flowers and enclosing a pair of smaller bracteoles situated at the base of the calyx-tube; calyx-tube cylindrical, slightly attenuated at the base, densely covered with long glochidiate, barbed and spine-like hairs; calyx-lobes 5, lanceolate to ovate-lanceolate, 2–3 mm. long, also covered with glochidiate, barbed and spine-like hairs, persistent and erect on the fruit; petals 5, pale yellow above, orange below, obovate, rotund at apex, 4–5 mm. long, 2–3.5 mm. broad, slightly emarginate, mostly glabrous; stamens about 20, in 1 or 2 series, filaments all filiform, incurved when young, 2.5–3 mm. long, somewhat broadened at the base, apex of anther slightly emarginate; style 2.5–3.5 mm. long, persistent on the fruit; capsule erect, cylindrical, attenuated at base, 7–10 mm. long, dark, with the persistent calyx-lobes and style obscurely striated; seeds about 20, irregularly ovate-orbicular, irregularly angled, not winged, brownish, minutely granulate-punctate, 1–1.3 mm. long, about 1 mm. broad.

Distribution: on dry hillsides, not common, in Idaho, Nevada, and California.

Specimens examined:

IDAHO: Lewis River, Rocky Mts., without date, *Nuttall* (ANSP TYPE).

NEVADA: Toyabe Mts., 6000 ft. alt., July 1868, *Watson 431* (US); Empire City, 20 June 1882, *Jones 3871* (CAS, M, P, US); Miller Mt., 7000 ft. alt., June 1885, *Shockley* (F); Carson City, 5000 ft. alt., 2 June 1897, *Jones* (P); Sierra Valley, 29 Aug. 1898, *Hillman* (P); Carson, 5 June 1890, *Hillman* (P); about Carson, June 1891, *Hillman* (P); hills north of Reno, 5500 ft. alt., 20 June 1900, *Stokes* (US); Dinsmore Camp, Hunter Creek Canyon, 6000 ft. alt., 20–25 June 1917, *Kennedy 1640* (CAS); Mount Rose, Washoe Co., 9500 ft. alt., 26 Aug. 1911, *Heller 10335* (US); mountains west of Franktown, Washoe Co., 5500 ft. alt., 2 July 1912, *Heller 10518* (US); north of Verdi, Washoe Co., 5300 ft. alt., 24 June 1913, *Heller 10874* (ANSP, C, F, M, US); Skyland Camp, near Glenbrook, Lake Tahoe, 29 June 1928, *Jussel* (CAS).

CALIFORNIA: Sierra Valley, without date, *Lemmon* (C); Sierra Co., coll. of 1874, *Lemmon 95* (ANSP, M); Green Horn Mts., Kern Co., 6000–7000 ft. alt., 7–15 June 1888, *Palmer 46* (US); Honey Lake Valley, Lassen Co., collection of 1890, *M. S. Baker* (C); range of Sierras east of Minarets, 19–22 Aug. 1899, *Congdon* (C); Avalon, Catalina Island, 28 June 1902, *Diehl 259* (P); Bonita Meadow, Tulare Co., 8500 ft. alt., 20–24 June 1904, *Hall & Babcock 5203* (ANSP); Palomar Mt., San Diego Co., 4800 ft. alt., 9 July 1904, *Chandler 5427* (C); Mount Breckenridge, Kern Co., 14 June 1905, *Grinnell 250* (US); Bishop Creek, Inyo Co., 6000 ft. alt., 31 May 1906, *Hall & Chandler 7254* (C); Sand Harbor, Lake Tahoe region, 1909, *Eastwood 209* (CAS); south side of Surprise Canyon, near Panamint City, Panamint Mts., Inyo Co., 7800 ft. alt., 14 June 1928, *Howell 3916* (CAS); dry sandy areas, Rock Creek, 5 miles north of Sherwin Grace, Mono Co., 21 June 1928, *Munz 11073* (P); 4 miles above Mono Lake, 1 July 1929, *Newsom* (B); June Lake, Mono Co., 5 July 1929, *Wright* (P).

**53a. M. congesta** (Nutt.) Torrey & Gray var. **Davidsoniana** (Abrams) Macbride in Contr. Gray Herb. N. S. 56: 28. 1918.

*M. Davidsoniana* Abrams, Fl. Los Angeles, 235. 1917.

*Acrolasia Davidsoniana* Abrams in Bull. Torr. Bot. Club **32**: 538. 1905.

Annual, erect, 2–3 dm. high; leaves somewhat pinnatifid to nearly entire; calyx-lobes lanceolate, 3 mm. long; petals 8 mm. long; bracts conspicuous, mostly scarious, narrow, concealing the capsules; seeds irregularly angled, only occasionally grooved.

Distribution: in open, pine forests of Nevada and California.

Specimens examined:

NEVADA: Slide Mt., Washoe Co., 7800 ft. alt., 11 July 1910, *Heller 10202* (CAS); between Minden and Lake Tahoe, 1 July 1929, *Newsom* (P).

CALIFORNIA: Pah Ute Peak, 7000–8000 ft. alt., April–Sept. 1897, *Purpus 5286* (M, US); Coldwater Fork of Lytle Creek, San Antonio Mts., 7 July 1918, *Johnston 2059* (P); Big Rock Creek, San Gabriel Mts., 4200 ft. alt., 25 May 1923, *Munz 6799* (P); Mount Wilson, 30 June 1902, *Abrams 2580* (P).

**54. M. micrantha** (Hook. & Arn.) Torrey & Gray, Fl. N. Am. **1**: 535. 1840; Walp. Rep. **2**: 225. 1843; Watson, U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 114. 1871; Brewer & Watson, Bot. Calif. **1**: 236. 1876; Greene, Fl. Francisc. 233. 1891; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 37–38. 1900; Jepson, Man. Fl. Pl. Calif. 650. 1925.

*M. micrantha* (Hook. & Arn.) Torrey & Gray var. *stricta* Davidson in Davidson & Moxley, Fl. South. Calif. 239. 1923.

*Bartonia micrantha* Hook. & Arn. in Bot. Beechey Voy. 343. 1840.

*Acrolasia micrantha* (Torr. & Gray) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

*Acrolasia micrantha* (Torr. & Gray) Rydb. var. *stricta* Davidson in Bull. So. Calif. Acad. Sci. **5**: 15. 1906.

*Acrolasia Catalinensis* Millsp. in Field Mus. Nat. Hist. Publ. Bot. **5**: 177. 1923.

Annual herbaceous plants from a stout tap-root; stems erect, more or less freely branching, simple below, dichotomous above, 10–45 cm. high, yellow or nearly white, somewhat pubescent below, hispid above with glochidiate and spine-like hairs; lower leaves alternate, ovate to lanceolate, 1–9 cm. long, 1.2–1.6

cm. broad, sinuately toothed or serrate, acute or acuminate at the apex, base often narrowed into a slender petiole, middle and upper leaves sessile, subcordate at the base, lanceolate or ovate-lanceolate to ovate, acute at the apex, 2.5–14 cm. long, 0.6–3.5 cm. broad, inconspicuously or deeply sinuate-toothed, upper surface of leaves covered with antrorse tuberculate-hispid hairs intermixed with glochidiate hairs, the lower surface densely covered with glochidiate hairs and a few antrorse spine-like hairs; flowers sessile, congested into compact cymose clusters at the apex of the branches, rarely corymbose, cymes 3–5-forked, as long as or slightly exceeding the floral bracts; bracts and bracteoles ovate to ovate-orbicular, obtuse at the apex, 0.3–1.4 cm. long, entire or slightly dentate, yellowish-green, scabrous; calyx-tube usually concealed by floral bracts, cylindrical, not attenuated, obtuse at base, 3–4 mm. long, terete or subangular, densely covered with long verticillate glochidiate antrorse spine-like hairs; calyx-lobes small, lanceolate, acute, 2 mm. long, 0.8–1 mm. broad, persistent and erect in fruit, yellowish, pubescence the same as on the calyx-tube; petals 5, imbricated, obovate to obovate-rotund, 3–3.5 mm. long, 2–3 mm. broad, attenuated at base, sparsely pilose near the apex, otherwise glabrous; stamens 10–20, in 1 series, the 5 stamens opposite the petals short, 2.5 mm. long, about 1.5 mm. broad, apex tricuspidate, middle cusp antheriferous, the two outer cusps shorter and sterile, the remaining filaments filiform, about 3 mm. long, slightly dilated at the base; style 3–4 mm. long, filiform, smooth, angled, apex and margins slightly pilose, persistent on the fruit; capsule cylindrical or quadrangular, not attenuated, obtuse at the base, about 1 cm. long, 2–2.5 mm. broad, brownish-green to brownish-black, papery or somewhat leathery, with persistent calyx-lobes and style; seeds 5–8, in 1 series on the narrow placentae, not compressed, mottled brown, minutely yellow-punctate, not winged, 1.5 mm. long and nearly as broad.

Distribution: dry hillsides and rocky canyons of the Coast Range Mountains in California from Trinity County southward throughout southern California, adjacent islands, and northern Lower California.

Specimens examined:

CALIFORNIA: TRINITY COUNTY—near Big Bar, 1400 ft. alt., 29 June 1923, *Tracy 6425* (C); LAKE COUNTY—southeast side of Snow Mt. above Bonnie View, 7 June 1919, *Heller 13237* (ANSP, CAS, F, M, US); SANTA CLARA COUNTY—Saratoga, Sept. 1893, *Burtt-Davy 245* (C); Black Mt., July 1903, *Elmer 4588* (C, CAS, M, P, US); MONTEREY COUNTY—Santa Lucia Mts., July and Aug. 1880, *Vasey 207* (US); Mt. Diablo, 30 May 1920, *Sutliffe* (CAS); SANTA BARBARA COUNTY—trail to Zaca Peak, Zaca Lake Forest Reserve, 19–30 June 1906, *Eastwood* (CAS); Mono Creek, 2500 ft. alt., 19 May 1907, *Hall 7794* (C); VENTURA COUNTY—Ojai and vicinity, 600 ft. alt., 22 May 1866, *Peckham* (US); base of bluffs, Point Mugu, 21 April 1928, *Howell 3749* (CAS); Santa Susana Pass, 29 May 1931, *Howell 6577* (CAS); LOS ANGELES COUNTY—sandy washes in canyons, Sierra Santa Monica, April–May 1890, *Hasse* (M, P, US); banks of San Gabriel River, 600 m. alt., 8 May 1898, *Leiberg 3382* (US); foothills near Sherman, 12 May 1901, *Braunton 55* (US); Monrovia, 14 June 1904, *Grant 6424* (C, F, RM); San Fernando Wash, 11 May 1913, *Eastwood 3161* (CAS); Griffith Park, 12 June 1915, *Macbride & Payson 817* (RM); Topango Canyon, Santa Monica Mts., 3 June 1916, *Hiatt* (P, US); Rubio Canyon, San Gabriel Range, 1800 ft. alt., 12 June 1918, *Peirson 119* (PH); east trail to Mt. Lowe, 3500 ft. alt., 14 May 1919, *Peirson 2302* (PH); burned-over area, San Dimas Canyon, 1500 ft. alt., 29 April 1920, *Munz & Harwood 3796* (P, RM, US); North Fork San Gabriel, 3000 ft. alt., 20 June 1921, *Peirson 2465* (PH); Fish Canyon, San Gabriel Mts., 1750 ft. alt., 21 May 1923, *Peirson 4450* (PH); San Gabriel Canyon, 1000 ft. alt., 23 April 1925, *Munz 9416* (P); near La Canada, 12 June 1926, *Reed 5240* (P); Soledad Canyon road at junction with Mint Canyon Road, 19 June 1927, *Craig 470* (P); Mandeville Canyon, near Santa Monica, 3 March 1928, *Bryan 70* (P); Los Alisos Canyon, Santa Monica Mts., 18 April 1931, *Epling* (M); Santa Catalina Island, 13 May 1890, *Brandegee* (CAS); Avalon, May 1895, *Trask* (US); Peebles Beach Road, 25 ft. alt., 31 May 1912, *Smith 5054* (F); SAN BERNARDINO COUNTY—desert washes, San Bernardino, 1880, *Parish & Parish 214* (ANSP); foothills, San Bernardino, May 1886, *Parish 214 A* (M); Waterman Canyon, San Bernardino Mts., 3000 ft. alt., 29 June 1894, *Parish 3486* (M, US); vicinity of San Bernardino, 1500 ft. alt., 11 May 1901, *Parish 4775* (P, US); southern slopes of San Bernardino Mts., 1700 ft. alt., 24 May 1909, *Parish 7105* (C); Cucamonga Canyon, 14 July 1915, *Davis 549* (P); Cucamonga Canyon, on ridge above Charcoal Camp, San Antonio Mts., 4700 ft. alt., 30 June 1918, *Johnston 2051* (P); Arrowhead Canyon near San Bernardino, 2000 ft. alt., 14 May 1919, *Spencer 1143* (CAS, P); San Dimas Canyon, 1500 ft. alt., 21 April 1921, *Munz & Harwood 3703* (P); San Bernardino Mts., 15 Aug. 1923, *Jones* (P); Arrowhead Springs, 1450 ft. alt., 7 May 1924, *Feudge 811* (P); Casey Trail to San Sevaine flats, San Antonio Mts., 3000 ft. alt., 10 July 1925, *Johnston* (P); Hesperia, 20 May 1929, *Jones* (P); RIVERSIDE COUNTY—Temecula Creek, 1 June 1899, *Hall 1219* (C); Santiago Peak Trail, Santa Ana Mts., 30 May 1931, *Howell 6589* (CAS); ORANGE COUNTY—Claymine Canyon, north of Santa Ana Mts., 1000 ft. alt., 3 July 1927, *Howell 2642* (CAS); SAN DIEGO COUNTY—San Clemente Canyon, dry slope of canyon south of "Lemon Tank," 10 April 1923, *Munz 6749* (P).

LOWER CALIFORNIA: Sanzel, 7 May 1883, *Orcutt & Fish* (US); Tia Juana Canyon, Guadalupe Island, in ravines at middle and south end of island, *Palmer 32* (M); 20 March 1897, *Anthony & Brandegee 259* (C, F, M, P, US).

55. **M. affinis** Greene in Pittonia 2: 103. 1890; Greene, Man. Bot. Reg. San Francis. Bay, 141. 1894; Abrams, Fl. Los Angeles & Vic. 256. 1904; Jepson, Fl. West. Mid. Calif. 322. 1901, ed. 2. 268. 1911; Jepson, Man. Fl. Pl. Calif. 651. 1925; Macbride in Contr. Gray Herb. N. S. 56: 25–26. 1918.

*Acrolasia affinis* (Greene) Rydb. in Bull. Torr. Bot. Club 30: 278. 1903.

Annual herbaceous plants from a slender tap-root, coarse, robust; stems usually white and shining, glabrous below, sparingly pubescent above with short glochidiate hairs, often simple and leafy below, widely branching above; leaves alternate, lanceolate or ovate-lanceolate, acute or obtuse at the apex, broadly lanceolate at the base, 2–9 cm. long, deeply sinuate-pinnatifid, or rarely almost entire, sessile, upper surface armed with jointed, straight or curved spine-like hairs with bulbous bases, the lower surface more densely covered with short slender barbed glochidiate hairs; flowers numerous, solitary in the forks of, or terminating, the branches; calyx-lobes attenuate-subulate, about 5–6 mm. long, spreading and mostly recurved at maturity; calyx-tube linear, subterete, 15–25 mm. long, clothed with stiff white barbed glochidiate hairs intermixed with long spine-like hairs with bulbous bases; petals yellowish-white, 6–8 mm. long, obovate with the base broadly spathulate; stamens 25–40, filaments linear; seeds short-prismatic, definitely grooved on the three angles, surfaces muriculate or muricate, often obliquely truncate at each end.

Distribution: in sandy or stony places in southwestern Arizona and central and southern California.

ARIZONA: Tucson Mts., 20 June 1892, *Toumey 163* (US); Tucson Mts., vicinity of Tucson, 11 April 1913, *Greenman & Greenman 46* (M); Tucson, 21 March 1919, *Eastwood 8067* (CAS).

CALIFORNIA: desert, southern California, 1881, *Parish & Parish 629* (F); SAN JOAQUIN COUNTY—Tracy, 10 April 1892, *Michener & Bioletti* (US); in sandy bottoms, Tracy, 25 April 1903, *Baker 2781* (CAS, F, M, P, RM, US); FRESNO COUNTY—7 miles southwest of Coalinga, 23 March 1925, *Munz 9157* (P); KERN COUNTY—Maricopa Hills, 15 May 1913, *Eastwood* (CAS); Caliente Creek, north base of Tehachapi Pass, 19 March 1925, *Munz 8987* (P); LOS ANGELES COUNTY—Mount

Black Jack, Santa Catalina Island, May 1896, *Trask* (M); Pasadena, May 1901, *Grant 773* (US); Playa del Rey, March 1903, *Braunton 866* (US); Santa Catalina Island, 20–25 July 1917, *Eastwood 6478* (CAS); between Lancaster and Victorville, 27 April 1930, *Hart* (CAS); VENTURA COUNTY—Simi, May 1902, *Hall 3236* (P); ORANGE COUNTY—hills back of Santa Ana, 1900, *Geis 517* (P); RIVERSIDE COUNTY—Hemet, May 4, 1904, *Baker 4141* (P); vicinity of Riverside, 1200 ft. alt., April 1903, *Hall 3829* (RM); Wrights, 17 miles west of Los Banos, 3 April 1912, *Wooton* (US); Chuckawalla Bench, Colorado Desert, 1200 ft. alt., 29 March 1922, *Jaeger 816* (US); SAN DIEGO COUNTY—dry hillsides near Tia Juana, 14 May 1903, *Abrams 3477* (M, P); IMPERIAL COUNTY—Indian Wells, Colorado Desert, 14 April 1922, *Munz & Keck* (P).

**56. M. dispersa** Watson in Proc. Am. Acad. **11**: 137. 1876; Brewer & Watson, Bot. Calif. **1**: 236. 1876; Greene, Fl. Francisc. 232. 1891; Howell, Fl. N. W. Am. **1**: 240. 1897; Coulter & Nelson, Man. Bot. Rocky Mts. 325. 1909; Macbride in Contr. Gray Herb. N. S. 56: 25. 1918; Rydberg, Fl. Rocky Mts. & Adj. Plains, ed. 2. 574. 1922; Jepson, Man. Fl. Pl. Calif. 651. 1925.

*M. albicaulis* Dougl. var. *integrifolia* Watson in U. S. Geol. Surv. Fortieth Parallel [Bot. King's Exp.] **5**: 114. 1871.

*M. integrifolia* (Wats.) Rydb. in Mem. N. Y. Bot. Gard. **1**: 271. 1900.

*M. albicaulis* Dougl. var. *genuina* Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 28. 1900.

*M. pinetorum* Heller in Bull. So. Cal. Acad. Sci. **2**: 69. 1903.

*M. dispersa* Wats. var. *obtusa* Jepson, Man. Fl. Pl. Calif. 651. 1925.

*M. dispersa* Wats. var. *pinetorum* Jepson, *Ibid.* 1925.

*Acrolasia integrifolia* (Wats.) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

*Acrolasia pinetorum* Heller in Muhlenbergia **2**: 99. 1905.

*Acrolasia dispersa* (Wats.) Davidson in Bull. So. Cal. Acad. Sci. **5**: 14. 1906.

*Acrolasia montana* Davidson, *Ibid.* 18. 1906.

*Acrolasia desertorum* Davidson, *Ibid.* 16. 1906.

*Acrolasia albicaulis* Dougl. var. *integrifolia* (Wats.) Daniels, Fl. Boulder, Colo. 174. 1911.

Annual, 1–3 dm. high; stems slender, erect, usually sparsely branched, smooth below, puberulent above; lower leaves narrowly lanceolate, entire, the middle leaves ovate-lanceolate, sinuate-dentate, rarely pinnatifid, the uppermost leaves ovate, entire, all leaves sessile; flowers small, mostly approximate toward the ends of the branches; calyx-lobes about 2 mm. long, persistent and erect in the mature fruit; petals obovate or spathulate, 3–4 mm. long; stamens 15–40, filaments filiform; capsule narrowly linear-clavate, 15–25 mm. long; seeds few, in a single row on each placenta, prismatic to somewhat rhomboidal, grooved on the angles, grayish-green, minutely muriculate, appearing almost smooth to the naked eye.

Distribution: sandy soil from Montana to Colorado, west to Washington, south to southern California.

Specimens examined:

MONTANA: Spanish Basin, 24 June 1897, *Rydberg & Bessey 4544* (F, RM, UM, US); Prickly Pear Canyon, 23 July 1887, *Williams 687* (US); Midvale, 27 July 1903, *Umbach 549* (F, US); Bozeman, June–Sept. 1905, *Blankinship 205* (ANSP, F, M, P, RM, UM, US).

WYOMING: Laramie Hills, 10 July 1891, *Buffum 346* (RM); Pole Creek, 30 June 1895, *Nelson 1375* (M, RM, US); Cummings, 28 July 1895, *Nelson 1455* (RM); Mammoth Hot Springs, 20 July 1899, *Nelson & Nelson 6006* (M, RM, US); Silver Gate, 24 July 1902, *Mearns 2252* (US); east of Afton, Lincoln Co., 30 June 1923, *Payson & Armstrong 3315* (ANSP, M, P, RM).

COLORADO: indefinite locality, 1868, *Vasey 195* (US TYPE); near Boulder, 6 July 1892, *Patterson 209* (F, M); near Hot Sulphur Springs, 3–8 Aug. 1907, *Ramaley & Robbins 3578* (RM); Morrison, 22 June 1918, *Clokey & Osterhout 3100* (CAS, M, P, RM); Boulder Canyon, 18 July 1921, *Clokey & Bethel 4216* (RM, US).

IDAHO: above Lewiston, 9 May 1892, *Sandberg, MacDougal & Heller 144* (ANSP, CAS, F, US); Lake Waha, Nez Perces Co., 21 June 1894, *Henderson 2714* (RM, US); Cedar Mountain, Latah Co., May 1897, *Elmer 787* (M, RM, US); Salmon, Lemhi Co., 23 June 1920, *Payson & Payson 1757* (CAS, RM).

UTAH: Antelope Island, June 1869, *Watson 430* (US); American Fork Canyon, 28 July 1880, *Jones 1461* (F, P); Asphalt, 12 July 1894, *Jones 5622* (US); Logan Canyon, Cache Co., 27 June 1909, *Smith 1709* (RM).

NEVADA: Glenbrook, Douglas Co., 22 July 1902, *Baker 1345* (CAS, F, M, P, RM, US); Carson sink region, Churchill Co., 15 July 1908, *Kennedy 1775* (CAS); Peavine Mountain, Washoe Co., 22 June 1909, *Heller 9763* (CAS); Hunter's Canyon, near Reno, 18 July 1913, *Hitchcock 542* (US).

WASHINGTON: Tumwater Canyon, Wenatchee River, 21 July 1893, *Sandberg & Leiberg 519* (ANSP, CAS, M, US); Charles Springs, Spokane Co., 8 July 1902, *Kreager 115* (M, US); Lookout Mountain, near Leavenworth, Chelan Co., 23 May 1913, *Thompson 6508* (M).

OREGON: Dalles, 10 June 1869, *Kellogg & Harford 292* (M, US); Swan Lake Valley, Klamath Co., 14 June 1896, *Applegate 213* (US) near Maupin, Wasco Co., 28–30 July 1922, *Abrams 9545* (P); Madras, Jefferson Co., 3 July 1931, *Howell 7177* (CAS).

CALIFORNIA: Yosemite National Park, June–Sept. 1866, *Bolander 4863* (F, M, US); Colton, San Bernardino Co., 28 April 1882, *Jones 2729* (P, US); near Havilah, Kern Co., 24 June 1891, *Coville & Funston 1086* (US); near Edgewood, Siskiyou Co., 28–31 July 1892, *Palmer 2574* (US); Frazier Mt., Ventura Co., 17 June 1896, *Dudley & Lamb 4570* (P); Pah Ute Peak, April–Sept. 1897, *Purpus 5102* (M, US); near Lily Lake, Eldorado Co., 23 July 1906, *Eastwood 897* (CAS); east of Red Clover Valley, Plumas Co., 4 July 1907, *Heller & Kennedy 8722* (ANSP, CAS, F, M, US); Deer Park, Placer Co., 15–19 June 1912, *Eastwood 683* (ANSP, CAS); Icehouse Canyon, San Antonio Mts., 30 July 1917, *Johnston 1602* (P); Palomar Mts., San Diego Co., 22 June 1924, *Munz 8293* (P); Surprise Canyon, Panamint Mts., Inyo Co., 14 June 1928, *Howell 3917* (CAS); Mather, Tuolumne Co., 28 May 1931, *Keck 1111* (CAS).

**56a. M. dispersa** Watson var. **latifolia** (Rydb.) Macbride in Contr. Gray Herb. N. S. 56: 26. 1918.

*M. latifolia* (Rydb.) Nels. in Coulter & Nelson, Man. Bot. Rocky Mts. 324. 1909.

*Acrolasia latifolia* Rydb. in Bull. Torr. Bot. Club **31**: 567. 1904.

Leaves coarsely toothed or entire, 5–10 cm. long; calyx-lobes 2.5–3 mm. long; petals obovate-spathulate, 5–6 mm. long; capsule linear-cylindrical, 2.5–3 cm. long.

Distribution: foothills and mountains, Colorado, Wyoming and west to Washington and south to central California.

Specimens examined:

WYOMING: Birdseye, 20 June 1920, *Nelson 9408* (M, P, RM, US).

COLORADO: along the Platte River, 12 June 1878, *Jones 220* (M, P); Rist Canyon, 29 June 1890, *Crandall 139* (US); between Sunshine and Ward, Aug. 1902, *Tweedy 5149* (RM); Morrison, Jefferson Co., 27 June 1920, *Clokey 3825* (ANSP, CAS, F, M, P, RM, US).

IDAHO: Kootenai Co., July 1888, *Sandberg* (F); Ketchum, Blaine Co., 20 July 1911, *Nelson & Macbride 1248* (F, M, P, RM, US).

UTAH: Wahsatch, 10 Aug. 1898, *Mulford 288* (M); Salt Lake City, July 1899, *Jones 1461* (F).

NEVADA: north of Verdi, 24 June 1913, *Heller 10870* (ANSP, F, M, US).

WASHINGTON: Whitman Co., 28–30 May 1904, *Beattie & Lawrence 2356* (ANSP); near Dog Creek, Skamania Co., 2 July 1923, *Suksdorf 11485* (ANSP, CAS, M).

OREGON: on Pine Creek, Gilliam Co., 8 June 1894, *Leiberg 188* (C, US); Dalles, Wasco Co., 23 May 1910, *Heller 10079* (C, CAS); Baker, 17–21 June 1916, *Eggleston 12621* (US); north of Dufur, Wasco Co., 3 July 1931, *Howell 7188* (CAS).

CALIFORNIA: Truckee, Nevada Co., 18 June 1885, *Sonne 117* (ANSP); lower end of Donner Lake, Nevada Co., 8 July 1903, *Heller 6865* (ANSP, M, P, RM, US); Loyalton, Sierra Co., 29 June 1918, *Eastwood 7796* (CAS).

**56b. M. dispersa** Watson var. **compacta** (Nels.) Macbride in Contr. Gray Herb. N. S. 56: 26. 1918.

*M. compacta* Nelson in Bull. Torr. Bot. Club **25**: 275. 1898.

*Acrolasia compacta* (Nels.) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

Stems low, compactly and numerously branched, whitish, pilose; leaves numerous, entire, obtuse, ovate-oblong, 1–3 cm. long, rough-hirsute; flowers yellow, sessile, small, in compact cymes at the ends of the branches; petals obovate, 3–4 mm. long; capsule linear-clavate, 10–13 mm. long; seeds 10–12.

Distribution: plains and foothills of Wyoming and Colorado westward to Washington and southward to California.

Specimens examined:

MONTANA: Craig, 21 June 1900, *Wilcox 322* (US); near Glacier Park Station, 15 Aug. 1919, *Standley 17667* (US); north of Windsor, 22 Aug. 1931, *Howell 7908* (CAS).

WYOMING: Parkman, 22 July 1896, *Nelson 2454* (M, RM); Mammoth Hot Springs, 20 July 1899, *Nelson & Nelson 6013* (M, RM, US); Moorcroft, Crook Co., 2 Aug. 1901, *Nelson 8552* (M, P, RM, US).

COLORADO: near Boulder, 6 July 1892, *Patterson 210* (US); Steamboat Springs, 10 Aug. 1898, *Shear & Bessey 4036* (US); near Boulder, July 1902, *Tweedy 5150* (RM).

IDAHO: Mannis Creek, Washington Co., 8 July 1899, *Jones 6324* (M, P, US); Squaw Creek, Custer Co., 23 July 1916, *Macbride & Payson 3384* (CAS, M, P, RM, US).

**57. M. nitens** Greene, Fl. Francisc. 234. 1891; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 360. 1900.

*Acrolasia nitens* (Greene) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

Annual or perennial, loosely spreading; lower branches somewhat decumbent, 3–6 dm. high; stems very white, shining; leaves few, thin, pinnately divided, linear-lanceolate; flowers solitary in the upper forks of the branches, somewhat clustered at the ends of the branches; petals oblong-obovate, obtuse or emarginate, 1.5–2.5 cm. long; stamens half the length of the petals, filaments subulate; capsule linear-clavate, 2–3.5 cm. long, hispid; seeds tuberculate, sharply angled.

Distribution: sheltered localities from western Arizona to southern California.

Specimens examined:

ARIZONA: Santa Catalina Mts., 16 March 1911, *Blumer 4247* (US); Yucca, 12 March 1912, *Wooton* (US); Kingman to Hillside, 24 March 1931, *Harrison, Kearney & Fulton 7630* (US); Fort Mohave, 23 March 1931, *Harrison, Kearney & Fulton 7568* (US).

CALIFORNIA: near Pete's Garden, Johnson Canyon, Panamint Mts., Inyo Co., 31 March 1891, *Coville & Funston 523* (US); west of Hesperia, San Bernardino Co., 17 May 1920, *Johnston 2306* (P, US); vicinity of Corn Spring, Chuckawalla Mts., Colorado Desert, 9–12 April 1922, *Munz & Keck 4886* (CAS, P).

**57a. M. nitens** Greene var. **Jonesii** (Urb. & Gilg) Darlington, n. comb.

*M. albicaulis* Dougl. var. *Jonesii* Urb. & Gilg, Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 29. 1900.

*M. albicaulis* Dougl. var. *spectabilis* Jones, Contr. West. Bot. **12**: 16. 1908.

Stems semi-decumbent toward the base, stout, whitish, shining; lower leaves deeply pinnately lobed, the upper leaves triangular and mostly entire; petals 8–12 mm. long, bright yellow.

Distribution: canyons and slopes, southern Utah and Arizona and Owen's Valley, California.

Specimens examined:

UTAH: Santa Clara, 28 April 1894, *Jones 5116* (C, M, P, RM, US).

ARIZONA: Yucca, 1884, *Jones 3900* (CAS, F, P, US); Yarnell Hill, near Prescott, 14 April 1927, *Harrison 3980* (US); between Superior and Kelvin, 30 March 1928, *Peebles, Harrison & Kearney 5164* (US); near Wickenburg, 31 March 1930, *Peebles & Loomis 6731* (US).

**57b. M. nitens** Greene var. **eremophila** (Jepson) Darlington, n. comb.

*M. Lindleyi* Torrey & Gray var. *eremophila* Jepson, Man. Fl. Pl. Calif. 650. 1925.

Petals rounded at the apex with a very slight acumination, 1.5–2.5 cm. long; stamens about one-third as long as the petals.

Distribution: desert mesas, Inyo and Kern Counties, California.

Specimens examined:

CALIFORNIA: Randsburg, 14 April 1905, *Heller 7692* (ANSP, F, M, US); Red

Rock Canyon, Mohave Desert, 8 May 1929, *Hoffmann* (CAS); Red Rock Canyon, Mohave Desert, 13 May 1930, *Howell 4935* (CAS).

This appears to be an intermediate variety between the species *nitens* and *Lindleyi*. However, its habit, flower, and shape of capsule would seem to indicate that it is more closely allied with *Mentzelia nitens*, to which it is here referred.

57c. **M. nitens** Greene var. **leptocaulis** Darlington, n. var.[39]

Stems slender, flexuous, 12–20 cm. high; leaves thin, linear-lanceolate, 3–4 cm. long, puberulent, subtending leaf elongated; flowers small, mostly solitary; petals 8–10 mm. long.

Distribution: valley of the Colorado River, Arizona.

Specimens examined:
ARIZONA: Williams Fork, 11 March 1876, *Palmer 157* (F, M TYPE, US).

58. **M. Lindleyi** Torrey & Gray, Fl. N. Am. **1**: 533. 1840; Brewer & Watson, Bot. Calif. **1**: 236. 1876; Greene, Fl. Francisc. 234. 1891; Jepson, Man. Fl. Pl. Calif. 652. 1925.

*M. Bartonia* Steud. Nomencl. ed. 2, pt. 2. 128. 1841.

*M. crocea* Kellogg in Proc. Cal. Acad. **7**: 110. 1876.

*M. aurea* Baill. Hist. Pl. **8**: 461, *fig. 309–310.* 1886; Urb. & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 33. 1900.

*Bartonia aurea* Lindley in Bot. Reg. **22**: *pl. 1831.* 1836.

*Chrysostoma aurea* Lilja, Fl. Sver. Suppl. **1**: 33. 1840.

*Creolobus aurea* Lilja, Fl. Sver. 67. 1839; Linnaea **15**: 264. 1841.

*Acrolasia aurea* (Lindl.) Rydb. in Bull. Torr. Bot. Club **30**: 278. 1903.

Annual, 1–6 dm. high, hispid; stems slender, simple or branched; leaves ovate to narrowly lanceolate, sessile, slightly clasping at base, 4–7 cm. long pectinately pinnatifid, with entire or toothed, lanceolate or linear lobes, the terminal lobe prolonged and mostly acute; flowers solitary or in clusters of 2 or 3 at the ends of the branches, axillary or terminal; calyx-lobes 10–15 mm. long, lanceolate, acute or acuminate; petals obovate, abruptly acuminate, 2–4 cm. long, golden-yellow with a vermillion base; stamens numerous, 2–3 cm. long, filaments mostly filiform, a few of the outer series somewhat dilated at base; capsule linear-clavate, elongated, 2.5–5.5 cm. long, somewhat thickened toward the apex, hirsute; seeds numerous, irregularly angular, minutely tuberculate.

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[39] **M. nitens** Greene var. **leptocaulis** Darlington, var. nov., caulibus tenuibus, flexuis, 12–20 cm. altis; foliis tenuibus, lineari-lanceolatis, 3–4 cm. longis, puberulis, folio subtento elongato; floribus parvis, plerumque solitariis; petalis 8–10 mm. longis.—Williams Fork, Arizona, 11 March 1876, *Palmer 157* (F, M TYPE, US).

Distribution: desert mesas, canyon slopes of southern California.

Specimens examined:

California: Lone Tree Valley, June 1862, *Brewer 1225* (US); Cedar Mountain, Alameda Co., May 1903, *Elmer 4354* (CAS, M, P, US); Tulare Co., 21 July 1904, *Culbertson 4306* (P); Mount Hamilton, Santa Clara Co., 31 May 1907, *Heller 8616* (ANSP, F, M, US); Sierra Nevada Co., 1911, *Peirson 750* (PH); Pine Valley, San Diego Co., 10 May 1920, *Spencer 1815* (P); Alameda Ridge, Santa Clara Co., 18 April 1926, *Howell 1900* (CAS); near Gardenville, Humboldt Co., 16 June 1931, *Howell 6715* (CAS).

## Section IV. Bicuspidaria Brewer & Watson

Section IV. Bicuspidaria Brewer & Watson in Bot. Calif. 1: 237. 1876; Urban & Gilg in Engl. & Prantl, Nat. Pflanzenfam. $3^{6a}$: 111. 1894; in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 78. 1900.

Annuals from a fusiform root; the stems, leaves, bracts, and capsules densely clothed with glochidiate and spine-like hairs; leaves sessile, sinuate-dentate, rarely pinnatifid; flowers subtended by bracts nearly concealing the calyx-tube; petals 5, yellow or orange; filaments numerous, apex dilated, cuspidate, the middle cusp bearing the anther, the two lateral cusps or lobes sterile; capsule cylindrical, attenuated, sessile; placentae broad; seeds 15–40, in 2 series, horizontal, irregularly gibbous-rugose, plicate, opaque, not winged. Spp. 59–61.

### Key to the Species of Section Bicuspidaria.

A. Bracts ovate, white, scarious, membranaceous with deeply laciniate-toothed margins and midveins.
  B. Petals 2–3 cm. long.................................*61. M. involucrata*
  BB. Petals 3.5–4.5 cm. long..............*61a. M. involucrata* var. *megalantha*
AA. Bracts narrowed, green and leaf-like.
  B. Flowers pedicellate.
    C. Middle anther-bearing lobe of filament 2 mm. long.......*60. M. tricuspis*

CC. Middle anther-bearing lobe of filament 0.5 mm. long................................................60a. *M. tricuspis* var. *brevicornuta*

BB. Flowers sessile.

C. Flowers yellow.

D. Middle anther-bearing lobe of filament as long as or shorter than lateral lobes..................................59. *M. hirsutissima*

DD. Middle anther-bearing lobe of filament elongated, twice the length of lateral lobes................59a. *M. hirsutissima* var. *stenophylla*

CC. Flowers orange......................59b. *M. hirsutissima* var. *nesiotes*

59. **M. hirsutissima** Watson in Proc. Am. Acad. **12**: 252. 1877; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 82. 1900; Johnston in Univ. Calif. Publ. Bot. **7**: 443. 1922; in Proc. Cal. Acad. Sci. IV. **12**: 1104. 1924.

*Bicuspidaria hirsutissima* (Wats.) Rydb. in Bull. Torr. Bot. Club **30**: 275. 1903.

Annual or biennial herbaceous plants, stout, erect with ascending branches; older stems and branches whitish and almost glabrous, the younger parts hirsute with short barbed, and long spreading spine-like hairs; leaves sessile, linear-lanceolate, acuminate, 3–8 cm. long, irregularly pinnatifid with divaricate acute segments and teeth, upper surface clothed with long spreading spine-like hairs, these appearing also along the prominent midvein below; subtending floral bracts acuminate, with narrow hirsute lobes; flowers terminal, axillary, sessile; calyx-tube somewhat concealed by floral bracts, 10–14 mm. long, longitudinally ridged, extremely hirsute with long stiff spreading spine-like hairs and short barbed pubescence; calyx-lobes 5, 16–20 mm. long, lanceolate, long-acuminate, strongly 1-nerved, with long scattered spine-like hairs, especially along the prominent nerve, and with shorter hairs on the margins, the margins revolute near the apex; petals yellow, acute, 3–3.5 cm. long, apex slightly barbellate; stamens numerous, 100–130, in 4–5 series, the filaments orange-colored toward the apex, shortly cuspidate, 10–12 mm. long, anthers oblong; style 14 mm. long; capsule oblong, 14–15 mm. long; seeds and mature fruit not seen.

Distribution: in Lower California and islands in the Gulf of California.

Specimens examined:

LOWER CALIFORNIA: Angel Island, Bay of California, coll. of 1876, *Dr. Street* (US cotype).

One specimen, apparently a part of the type collection, was seen which, however, had no mature seeds or fruit. Urban and Gilg described the fruit as a cylindrical capsule 1.8–2.1 cm. long and 6–7 mm. broad, somewhat attenuated, subchartaceous, brownish-green, scabrous, 20-nerved, the alternating nerves less conspicuous; the calyx-lobes blackish, shriveled, persistent, irregularly erect or slightly recurved; the seeds 30–40 on biseriate placentae, horizontal, irregularly oval or oblong, about 2 mm. long and 1.5 mm. broad, irregularly gibbous-rugose, plicated, gray or grayish-yellow, minutely granulated-punctate, not winged.

There is a tendency for the calyx-lobes to become pinnately divided as in the floral bract.

**59a. M. hirsutissima** Watson var. **stenophylla** (Urb. & Gilg) Johnston in Univ. Calif. Publ. Bot. 7: 443. 1922.

*M. stenophylla* Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] 76: 80. 1900.

Middle lobe of the anther greatly elongated, twice the length of the lateral lobes.

Distribution: in southern California, and the northern third of Lower California.

Specimens examined:

CALIFORNIA: Mountain Springs, San Diego Co., 12 May 1894, *Schoenfeldt 3069* (US).

LOWER CALIFORNIA: San Quentin, 22 April 1886, *Orcutt 1357* (F, M); Cajon de Santa Maria, 14 May 1889, *Brandegee* (C); Calamujuet, 10 May 1889, *Brandegee* (ANSP, US); opposite Pond Island, Angel de la Guardia Island, 30 June 1921, *Johnston 4229* (CAS).

**59b. M. hirsutissima** Watson var. **nesiotes** Johnston in Univ. Calif. Publ. Bot. 7: 443–444. 1922.

Leaves thin, coarsely toothed; flowers orange-colored.

Distribution: on San Benito, Natividad, and Cedros Islands, Lower California.

Specimens examined:

LOWER CALIFORNIA: Los Angeles Bay, Gulf of California, 1887, *Palmer 591* (US); Cedros Island, 18–20 May 1889, *Palmer 712* (F, US); Cedros Island, March–June 1897, *Anthony 280* (C, F, M, US); Cedros Island, 1897, *Anthony* (US); San Benito Island, 28 March 1897, *Brandegee* (C TYPE); Natividad Island, 10 April 1899, *Brandegee* (C); San Bertolome Bay, 14 March 1911, *Rose 16230* (US); Cedros Island, 12 March 1911, *Rose 16152* (US).

60. **M. tricuspis** Gray in Am. Nat. **9**: 271. 1875; Brewer & Watson, Bot. Calif. **1**: 237. 1876; Watson in Proc. Am. Acad. **12**: 252. 1877; Engl. & Prantl, Nat. Pflanzenfam. **3$^{6a}$**: 111. 1895, and ed. 2. **21**: 534. 1925; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 78–79. 1900; Johnston in Univ. Calif. Publ. Bot. **7**: 444. 1922; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 361, 363. 1925; Jepson, Man. Fl. Pl. Calif. 649. 1925.

*Bicuspidaria tricuspis* (Gray) Rydb. in Bull. Torr. Bot. Club **30**: 275. 1903.

*Acrolasia tricuspis* (Gray) Davidson in Bull. So. Calif. Acad. Sci. **9**: 71. 1910.

Annual herbaceous plants, scabrous, from a slender tap-root, diffusely branched from the base, 0.5–2.4 dm. high; stems erect or spreading, yellowish-white, striate, densely hispid with short verticillate glochidiate and scattered longer spine-like hairs, the older parts of the stem sometimes becoming almost smooth; leaves alternate, linear-lanceolate to ovate-lanceolate, 2–7 cm. long, subentire to deeply sinuate-dentate, acute at the apex, subsessile or attenuated at the base into a short petiole, upper surface with glochidiate and a few spine-like hairs, especially on the leaf margins, lower surface densely hispid with glochidiate spine-like hairs scattered along the midvein; flowers terminal, short-pedicellate, solitary, yellow, subtended by small foliaceous bracts; bracts linear-lanceolate, coarsely sinuate-dentate or pinnatifid, long-attenuated at the apex, not concealing the calyx-tube; calyx-tube cylindric or turbinate, obtuse at the base, 10–15 mm. long, short-pedicelled, light brown, often mottled, densely hirsute; calyx-lobes lanceolate-subulate, erect before anthesis, later becoming reflexed, long-acuminate, 10–13 mm. long, lighter in color than the calyx-tube, pubescent; petals spathulate-obovate, apiculate, 2–2.5 cm. long, narrowed or unguiculate at the base, minutely pilose at the apex, otherwise glabrous; stamens 80–100, in 4 series, the inner reflexed and the outer erect, linear, 8–9 mm. long, slightly dilated toward the cuspidate apex, the lateral cusps sterile and twice the length of the middle cusps bearing the oblong-linear anther; style 3-cleft, angled or subterete, apex densely papillose; capsule cylindric, reflexed at apex of short pedicel, crowned by the persistent reflexed calyx-lobes and withered style; seeds numerous, in 2 series on each placenta, irregularly oblong to oblong-oval, strongly rugose, grayish-green, minutely granulate-punctate, not winged.

Distribution: desert areas and dry hillsides and canyons in southern Utah and Nevada, westward to the Mohave and Colorado Deserts, south to western Arizona.

Specimens examined:

UTAH: southern Utah, 1877, *Palmer 173* (US).

NEVADA: Vegas Wash, Lincoln Co., 350 m. alt., 2 May 1891, *Bailey 1892* (US); St. Joe, May 1894, *Jones 5029ak* (P); Eldorado Canyon, Lincoln Co., Jan.–April 1895, *Mills 8* (US); Moapa, 1400 ft. alt., 27 April 1904, *Jones* (P); Moapa, 8 April 1905, *Goodding 2180* (C, M, RM); Overton, Clark Co., 1500 ft. alt., 8 June 1912, *Heller 10440* (US); south of St. Thomas, 480 m. alt., 25 April 1919, *Tidestrom 9141* (US).

ARIZONA: Yucca, 17 May 1884, *Jones* (P); Franconia, 900 ft. alt., 17 April 1903, *Jones* (P).

CALIFORNIA: Fort Mohave, 18 Feb. 1861, *Cooper* (US); Whitewater, Colorado Desert, April 1876, *Lemmon 258* (C); The Needles, 5 May 1884, *Jones 3824* (C, CAS, F, P, RM, US); gravelly washes, Needles, 500 ft. alt., 1 April 1920, *Munz & Harwood 3639* (P, RM, US p. p.).

**60a. M. tricuspis** Gray var. **brevicornuta** Johnston in Univ. Calif. Publ. Bot. 7: 444. 1922.

*Acrolasia tridentata* Davidson in Bull. So. Calif. Acad Sci. 9: 71. 1910.

Lateral lobes of the filament short, oblong, about 0.5 mm. long.

Distribution: in the Mohave and Colorado Deserts, representing the western limit of distribution of the species.

Specimens examined:

CALIFORNIA: Daggett, San Bernardino Co., *Brandegee* (C); Mohave Desert, May 1881, *Parish* (US); southern base of Calico Mts., 22 April 1915, *Shreve* (A); 10 miles north of Barstow, 14 May 1922, *Johnston 6526* (P); Newberry Mts., 7 miles east of Daggett, San Bernardino Co., 6 April 1924, *Munz & Keck 7847* (P); foot of Mountain Springs Grande, Imperial Co., 16 April 1927, *Peirson 7209* (PH); mud hills near Red Rock Canyon, northwest of Mohave Desert, Kern Co., 13 May 1930, *Howell 4947* (CAS).

**61. M. involucrata** Watson in Proc. Am. Acad. **20**: 367. 1885; Urban & Gilg in Nov. Act. Nat. Cur. [Abh. K. Leop.-Carol. Deutsch. Akad. Naturf.] **76**: 83. 1900; Johnston in Univ. Calif. Publ. Bot. **7**: 443. 1922; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 361. 1925; Jepson, Man. Fl. Pl. Calif. 649. 1925.

*Bicuspidaria involucrata* (Wats.) Rydb. in Bull. Torr. Bot. Club **30**: 275. 1903.

Annual herbaceous plants, hispid, branching from base, rarely simple, 1–3 dm. high; stems stout, erect, with white, longitudinally striated epidermis, densely pubescent, especially upper branches, with short verticillate glochidiate, and a few scattered long spine-like hairs; leaves alternate, linear to oblong-lanceolate, acute or slightly obtuse at the apex, 4–12 cm. long, coarsely sinuate-dentate, lower leaves attenuated into a short petiole, upper sessile, mostly cordate-amplexicaul at base, upper surface of leaves clothed with short spine-like hairs, lower surface, the prominent midvein, and margins densely hispid with verticillate glochidiate and some long spine-like hairs; flowers terminal, solitary, sessile, pale yellow, subtended by a pair of broadly ovate bracts; bracts acute or acuminate, white, scarious, sessile, subcordate-amplexicaul, with deeply laciniate-toothed green margins and midveins covered with short glochidiate and long stout spine-like hairs; calyx-tube subcylindrical, obtuse at the base, 15–30 mm. long, conspicuously 10-nerved, hispid with verticillate glochidiate and spine-like hairs, concealed by the subtending bracts; calyx-lobes long-acuminate, shorter than the calyx-tube, margins revolute, the prominent midvein with short glochidiate and long spine-like hairs; petals 5, obovate to oblanceolate, triangularly apiculate at the apex, base narrowed and unguiculate, 2–3 cm. long, sparsely pilose; stamens numerous, in 4–5 series, inner inflexed, outer erect, the 5 filaments opposite the sepals 3-nerved, remainder 1-nerved, linear, dilated toward apex, bicuspidate with long linear cusps, anther oblong; style tubular, 3 flattened stigmatic lobes at apex; capsule subcylindrical, slightly attenuated to an obtuse base, 1.5–2.5 cm. long, brownish-black, scabrous, papery, 20-nerved, the alternating nerves less conspicuous, crowned with persistent withered style and the irregular erect calyx-lobes; seeds 15–40, in 1 or 2 rows on each placenta, horizontally flattened, not margined, irregularly oval to quadrangularly-rotund, gibbous-rugose, gray or yellowish-gray, 3–3.5 mm. long, minutely and densely granulate-tuberculate.

Distribution: in desert areas and on dry hillsides of western Arizona, north and westward to the Colorado and Mohave Deserts, and south to Sonora, Mexico.

Specimens examined:

ARIZONA: Yucca, 15 May 1884, *Jones* (P); Valley of the Hassayampa, April 1876, *Palmer 598* (C, M, US cotype); Chemehuevis, 4500 ft. alt., 1 April 1903, *Jones* (P); Agua Caliente, 27 Feb. 1914, *Carlson* (CAS); hills near Evans, road from Coariz to Parker, 28 April 1915, *Shreve* (A); Gila Mts., Yuma Co., 4 March 1927, *Harrison 3601* (US); near Dome, Yuma Co., 10 March 1928, *Peebles & Harrison 5049* (US).

CALIFORNIA: Colorado Desert, dry gravelly hill slopes, Nov.–Dec. 1852, *Schott 1* (F); mountains, Riverside, 25 Jan. 1858, *Newberry* (US); Mohave River district, San Bernardino Co., 1876, *Parry & Lemmon 138* (US TYPE—also specimen of var. *megalantha*); Whitewater, Colorado Desert, 1881, *Parry 210* (M); The Needles, 8 May 1884, *Jones 3855a* (US); Borregos Springs, 18 April 1895, *Brandegee* (C); Shepherd's Canyon, 4600 ft. alt., 30 April 1897, *Jones* (P, US); San Felipe, May–Oct. 1898, *Purpus* (ANSP, C, RM); sandy soil, Signal Mountain, San Diego Co., 2 April 1903, *Abrams 3166* (M, P); Colorado Desert, April 1905, *Brandegee* (US); Kelso, 3000 ft. alt., 2 May 1906, *Jones* (P); River Mountain, Colorado River, 18 March 1910, *Grinnell* (C); San Felipe Creek, Colorado Desert, San Diego Co., 14 April 1913, *Eastwood 2712* (CAS, M, US); Needles, gravelly wash, 500 ft. alt., 1 April 1920, *Munz & Harwood 3639* (US); Palm Springs, Colorado Desert, 400 ft. alt., 12 April 1922, *Spencer 1143* (P); near Palm Wash, Colorado Desert, San Diego Co., 24 March 1928, *Howell 3510* (CAS).

MEXICO: Port Lobos, Sonora, 28 March 1884, *Pringle* (F, US); near Libertad, Sonora, 21 March 1926, *Shreve 5848* (US); hill north of Libertad Bay Inn, Sonora, 21 March 1926, *Long 45* (A, US).

**61a. M. involucrata** Wats. var. **megalantha** Johnston in Univ. Calif. Publ. Bot. 7: 443. 1922.

Petals 3.5–4.5 cm. long.

Distribution: in the Colorado Desert, California.

Specimens examined:

CALIFORNIA: Colorado Desert, *Parish* (C); Santa Maria Mts., Colorado Desert, *Schellenger 1* (P); Whitewater, Colorado Desert, April 1876, *Lemmon 258* (F); Whitewater, 1880, *Parish & Parish 210* (ANSP, F); in semi-arid land, Whitewater, 19 April 1913, *Piemeisel 3481* (US); Painted Canyon, near Mecca, 30 March 1921, *Evans* (P); near Mecca, Colorado Desert, 160 ft. alt., 29 March 1922, *Spen-*

*cer 1900* (M, P); Cottonwood Springs, Riverside Co., 12 April 1924, *Evermann* (CAS, M); Westmoreland, Imperial Co., March 1926, *Anderson* (CAS); Coachella Valley, Colorado Desert, Riverside Co., 29 March 1927, *Stason* (CAS).

The variety *megalantha* differs from the typical species only in the larger more conspicuous flowers of brighter yellow. Watson, in describing the species *involucrata,* had before him a small-flowered specimen with petals about one inch in length, which became the typical form. Both the species and variety have the characteristic large white green-margined floral bracts. The variety is confined in its distribution to the Colorado Desert, whereas the species, though most common in the Colorado Desert, extends eastward into Arizona and southward into Sonora.

### SPECIES EXCLUDED.

*Mentzelia cordata* Kellogg in Proc. Cal. Acad. **2**: 33. 1863 = **Eucnide cordata** Kellogg.

*Mentzelia gronoviaefolia* Fisch. & Mey. Ind. Sem. Hort. Petrop. **10**: 54. 1845 = **Eucnide bartonioides** Zucc.

*Mentzelia lobata* Walp. Rep. **2**: 224. 1843 = **Eucnide lobata** Gray.

*Mentzelia synandra* Nels. in Bot. Gaz. **47**: 428. 1909 = **Eucnide urens** Parry.

*Mentzelia urens* Parry ex Gray in Proc. Am. Acad. **10**: 71. 1874 = **Eucnide urens** Parry.

*Mentzelia urens* Vell. Fl. Flum. **5**: *pl. 97*. 1825 = **Loasa parviflora** Schrad.

### DOUBTFUL SPECIES.

*Acrolasia elata* Phil. in Anal. Univ. Chile **85**: 5. 1894. Chile.

*Acrolasia ngaumderensis* Guerke in Bauer, Deutsch. Niger-Bunue Exped. 163. Africa.

*Mentzelia corumbaensis* Hoehne in Comm. Linh. Telegr. Matto Grosso Amaz. Annexo 5, Bot. **6**: 54, *pl. 126*. 1915. Brazil.

*Mentzelia fragilis* Huber in Bull. Herb. Boiss. II. **1**: 314. 1901. Brazil.

*Mentzelia grandiflora* Ruiz & Pav. ex Don, Hist. Dichl. Pl. **3**: 66. 1834. Peru.

*Mentzelia hirta* Pav. ex Don, Hist. Dichl. Pl. 3: 66. 1834. Mexico.

*Mentzelia ovata* Thomps. in Asa Gray Bull. 7: 37. 1894 [as *orata*]; abstract in Just's Bot. Jahresb. $23^2$: 90. 1897, *nomen nudum.*

*Mentzelia propinqua* Aresch. in Freg. Eugenies Resa, Bot. 133. 1910. Ecuador.

## LIST OF EXSICCATAE

The collector's numbers are indicated by *italics,* the collections without numbers are indicated by a dash. The numbers in parentheses refer to the species number used in this monograph.

Abrams, L. R. *872 2686, 9502* (22); *3589* (51b); *1850* (52a); *2580* (53a); *3477* (55); *9545* (56); *3166* (61).
Aiton, G. B. — (21); — (22).
Allen, G. N. — (22).
Allart, *188* (19).
Altamirano, F. — (4).
Anderson, A. L. — (36).
Anderson, F. W. *161* (20); — (22).
Anderson, W. T. — (61a).
Anderson, — (19).
Andrè, E. *3187* (2); *514* (19).
Andrews, D. M. — (21).
Anect, Bro. *104* (36).
Anthony, A. W. *300* (15); —, *280* (59b).
Anthony, A. W. & T. S. Brandegee. *259* (54).
Applegate, E. I. *213* (56).
Arsène, Bro. *35, 47, 5203, 5288, 5388, 10609* (4); *470, 1863* (17).
Arsène, Bro. & Nicolas. *5291* (14).
Austin, R. M. —, *855, 21432* (22).
Babcock, E. B. — (22).
Bacigalupi, R. *818* (36).
Bailey, V. — (20); — (21); *888* (36); *1892* (60).
Baker, C. F. — (20); — (21); *3452* (22); *370, 471* (39); *470* (40); *203, 467* (51); *2781, 4141* (55); *1345* (56).
Baker, C. F., F. S. Earle & S. M. Tracy. *853* (36); *483* (39); *496* (40); *14* (51b).
Baker, H. P. — (20); — (21).
Baker, M. S. *548* (22); — (53).
Ball, C. R. *1161* (20); *1212* (21).
Bang, M. *748, 1082* (3); *1005* (12).
Barber, C. H. *274* (22).
Barber, C. H. & C. M. Tounsend. — (19).
Barlow, B. — (37a).
Bartholf, J. H. — (22).
Bartholomew, E. — (20).
Bartlett, A. F. — (21).
Bartlett, H. H. *10584* (13); *10188* (14); *10817* (19).
Bartram, E. B. — (16); *345* (36).
Beard, A. — (36).
Beattie, R. R. & W. H. Lawrence. *2356* (56a).
Benke, H. C. *4165, 5036* (36).
Berlandier, J. L. *654* (4); *590, 2000* (21); *522* (34).
Bertero, E. J. — (19).
Bethel, E. & E. B. Payson. *1616* (21).
Bereman, S. D. *734* (21).
Bigelow, J. M. — (13); — (21); — (36).
Bigelow, J. M., C. C. Parry, C. Wright, C. Schott. *390* (34).
Bilimek, *270* (4).
Bishop, C. — (41).
Blake, S. F. *349* (21).
Blankinship, J. W. *205* (56); — (13); —, *99, 697* (20); —, *98* (22).
Bloomer, H. G. — (22).
Blumer, J. C. *1509, 1609* (36); *4247* (57).
Bodin, J. E. — (39).
Bolander, H. N. *2677, 6256* (22); *4853* (56).
Bolland, G. *31* (19).
Bordeau, — (3).

Botteri, M. *558, 769* (4).

Bourgeau, E. *295* (4).

Brandegee, K. — (22); — (31); — (36); — (60a).

Brandegee, T. S. —, *377* (13); — (19); — (20); *89* (21); *532* (22); —, *842* (38); *1243, 1282* (39); — (54); — (59a); — (59b); — (61).

Braunton, E. *1123* (22); *55* (54); *866* (55).

Bray, W. L. *223* (13).

Brewer, W. H. *769, 1315, 2056* (22); *506, 575* (52); *1225* (58).

Bridges, T. *116* (22); — (33).

Britton, N. L. *9* (16).

Britton, N. L. & C. F. Millspaugh. *5516* (16).

Britton, N. L., E. G. Britton & C. S. Gager. *7393* (19).

Britton, N. L. & J. A. Shafer. *2914* (19).

Broadhead, G. L. — (13); *22* (22).

Brown, A. P. — (13).

Brown, H. E. *925* (22).

Bruhin, T. A. — (20).

Brumback, F. M. & C. A. Davies. *966* (21); *96* (36).

Bryan, M. *70* (54).

Buchtien, O. *4257* (19).

Buckley, S. B. — (14).

Buffum, B. C. *347* (20); *345* (21); *346* (56).

Burgess, A. B. *778* (16).

Burgelhaus, F. H. — (20).

Bush, B. F. *238*, —, *1178, 5034* (13).

Butler, G. D. —, *14, 57* (13); *1789* (22).

Calkins, W. W. — (16).

Campbell, E. H. — (22).

Canby, W. M. — (16); — (20).

Carleton, M. A. *216* (13); *328* (21); *378* (34); — (38).

Carlson, J. I. — (61).

Carrey, — (20).

Cary, M. *348* (36); *345* (51b).

Chandler, H. P. — (22); *5427* (53).

Chapman, A. W. — (16).

Chestnut, V. K. & E. K. Drew. —, *594* (22).

Clark, J. A. *313* (22).

Clemens, Mr. & Mrs. J. *541, 542* (13); *540* (34).

Clemens, Mrs. J. *11694* (13); — (21); — (22); *11695* (33).

Clements, F. E. *2772* (21); *37* (38); *2843* (20).

Clokey, I. W. *4218* (20); —, *2628, 2947, 3822* (21); *3820* (36); *4214* (38); *3825* (56a).

Clokey, I. W. & G. E. Osterhout. *3095* (52a); *3100, 4216* (56).

Cockerell, T. D. A. — (9).

Congdon, J. W. — (53).

Conzatti, C. —, *1758, 4094, 4359* (1); *1590, 2035* (4); *4051* (11); *1458, 1985* (14).

Conzatti, C. & V. Gonzalez. *19* (14).

Cook, O. F. & G. B. Gilbert. *280, 545* (3).

Cooper, J. G. — (60).

Cooper, W. S. —, *425* (21); *366* (22).

Cotton, J. S. *433, 808, 1408* (22); *1037* (51b).

Coville, F. V. *1216* (51b).

Coville, F. V. & E. I. Applegate. *738* (22).

Coville, F. V. & F. Funston. *956* (22); *454, 709* (32); *351, 410* (51b); *748* (52); *1086* (56); *523* (57).

Coville, F. V. & J. B. Leiberg. *137* (22).

Cowen, J. H. — (13); *180* (21); — (41).

Cowles, H. C. *1418* (22); *221* (23).

Craig, T. *470* (54).

Craig, T., V. Newsom & M. Hilend. *89* (52a).

Crandall, C. S. —, *1212* (21); *138* (39); *139* (56a).

Crawford, J. — (16).

Cronkhite, H. M. *46* (52a).

Culbertson, J. —, *4681* (22); *4306* (58).

Cuming, H. *1011* (3); *268* (33).

Curran, H. M. & M. Haman. *29* (19).

Curtiss, A. H. *659, 959, 5842* (16).

Daers, A. R. *549* (54).

Daniels, F. *678* (21); *77* (36).

Davy, J. B. *4278* (22); *245* (54).

Dawe, M. T. *559* (19).

Deam, O. R. — (20).

Demaree, D. *7768* (21).

Dewey, L. H. — (33).

Diehl, I. E. — (13); *680, 685* (37a); *259* (53).

Donaghe, R. *52* (22).

Drummond, T. *49, 90* (13); *302* (17).

Drushel, J. R. — (39).

Dudley, W. R. & F. N. Lamb. *4508* (52a); *4570* (56).
Duncan, C. D. *437* (22).
Duncan, J. T. *57* (13); *37* (21).
Dunnock, S. — (22).
Duran, V. *549* (22); *550* (52a).
Earle, F. S. *317* (35); *19* (40).
Eastwood, A. — (20); —, *16, 152* (21); —, *1414, 7719, 10667* (22); — (27); —, *7222* (30); *6327, 6344* (37a); *5932, 6162, 8549, 15641* (36); — (39); *5633* (40); —, *31, 5092* (41); *5236, 5078, 7795, 9549, 18310* (52a); *209* (53); —, *3161* (54); —, *6478, 8067* (55); *683, 897* (56); *7796* (56a); *2712* (61).
Eggert, H. — (13); — (14); — (21); — (33); — (34); — (37).
Eggleston, W. W. *15417, 15542* (21); *14936* (22); *16706* (34); *10962, 15400* (36); *6737, 18631* (51b); *12621* (56a).
Ehrenberg, C. *202* (4).
Ekman, E. L. *2207* (19).
Elias, Bro. *779* (19).
Elliott, C. E. *31* (3).
Ellis, C. C. *170* (36).
Elmer, A. D. E. *4903* (52); *4588* (54); *787* (56); *4354* (58).
Elrod, M. J. —, *161* (22).
Emig, W. H. *611, 828* (13).
Engelmann, G. — (18); — (20); — (21); — (22); — (36); — (38); — (39).
Engelmann, H. — (21); — (22).
Epling, C. C. — (54).
Ervendberg, L. C. *206* (19).
Evans, W. H. — (37a).
Evans, — (61a).
Evermann, B. W. — (20); — (21); — (61a).
Fendler, A. *1876* (3); *453* (19); *240* (20); *241* (21); *242* (36); *243* (39).
Fernow, B. E. — (37a).
Ferris, R. S. *5660* (19).
Ferris, R. S. & C. D. Duncan. *3229* (13); *3351* (21); *2338* (37); *2842* (37a).
Ferris, R. S. & Y. Mexia. *5282* (19).
Feudge, J. B. *1561* (31); *811* (54).
Fiebrig, K. *2316* (19).
Fischer, W. *61* (33).
Fisher, G. L. *295* (13); *95* (21).
Fitch, H. M. *77* (20).
Fitch, L. A. —, *39* (20).
Forwood, W. H. —(22); — (37).
Fredholm, A. *5500* (16).
Fremont's Expedition. *123* (13); — (20); *177* (21); *243* (34).
Friedrichstahl, E. *378* (19).
Fritchey, J. Q. A. — (36).
Fromme, F. — (20).
Fuertes, M. *1301* (19).
Gale, N. P. *373* (22).
Galeotti, H. *3682* (1); *3681, 3683* (4).
Garber, A. P. — (16).
Garrett, A. O. *1495, 3232* (22).
Garvens, W. — (16).
Gaumer, G. F. *821* (19).
Gay, Cl. —, *357* (33); *662* (47).
Geis, H. D. *121* (51); *517* (55).
Glatfelter, N. M. — (13); — (21).
Goddard, R. E. *24* (22).
Goldman, E. A. *431, 1082* (36); *2857* (37a).
Goll, G. P. *704* (19).
Gonzalez, V. — (14).
Goodding, L. N. *477* (20); *1171, 1725* (22); *2273* (24); *776* (42); *943* (51b); *2180* (60).
Goodman, G. J. & C. L. Hitchcock. *1149* (36).
Gordon, A. — (13).
Gorman, M. W. *665* (22).
Grant, A. L. *1686* (22).
Grant, G. B. *5276* (22); *6424* (54); *773* (55).
Gray, I. J. *2108* (22).
Greene, E. L. — (18); *979* (22).
Gregg, J. *782* (14); *528* (19); *102* (36).
Greenman, J. M. *3836* (13).
Greenman, J. M. & M. T. Jr. *5055, 5114* (19); *46* (55).
Griffiths, D. — (20); *5548* (21); *5724* (27); *4326* (36); *5170, 5792* (37a); *4964* (39); *3976* (51); *4354* (51b).
Griffiths, D. & B. Hunter. *388* (22).
Griffiths, D. & E. L. Morris. *390* (22); *120* (52a).
Griffiths, D. & J. J. Thornber. *192* (36).
Grinnell, F. *250* (53).
Grinnell, J. — (61).
Groth, H. A. *21* (13); *140* (34).

Gurney, J. — (21).
Hahn, L. *29* (4).
Hall, *11* (3).
Hall, E. — (13); — (21); *199* (22); —, *227* (33).
Hall, E. & J. P. Harbour. *569* (21); *570* (36).
Hall, G. R. — (22).
Hall, H. M. — (22); *5925* (36); *9961* (52); *1219, 7794* (54); *3236, 3829* (55).
Hall, H. M. & H. D. Babcock. *5203* (53).
Hall, H. M. & H. P. Chandler. *502* (22); *6824* (45); *7140* (52a); *7254* (53).
Haley, G. — (22).
Hanson, H. C. *591* (36); *932* (37); *A149* (37a).
Hanson, H. H. *150* (39).
Hanson, H. C. & E. E. Hanson. *616* (37).
Hapeman, H. — (20).
Harper, E. T. & S. A. — (21); — (36).
Harrison, G. J. *4765, 8254* (18); *8184* (19); *1781* (36); *4008* (51); *8724* (52a); *3980* (57a); *3601* (61).
Harrison, G. J. & T. H. Kearney. *6364* (36); *8410* (45).
Harrison, G. J., T. H. Kearney & H. J. Fulton. *7630, 7568* (57).
Harshbarger, W. A. — (13).
Hart, C. — (55).
Hartman, C. V. *93* (14).
Hartweg, T. *16* (4).
Harward, W. — (36); *20* (37a).
Hasse, H. E. — (54).
Hatcher, J. B. — (21).
Haught, O. — (3); *217* (19).
Havard, V. — (14); — (21); — (22); — (27); — (34); — (36).
Hayden, F. V. —, *40* (20); — (21); — (34).
Hayward, H. E. *2046, 2444* (21).
Headly, F. B. *16* (51).
Heermann, A. L. — (22).
Heimwachner, *69* (19).
Heller, A. A. *1791* (14); *6091* (19); *14296* (21); *651, 6008, 9520, 11053, 11682, 12974* (22); *10980a* (28); *1896* (34); *8232* (51); *9763, 7614* (52a); *7634* (52b); *10335, 10518, 10874* (53); *10202* (53a); *13237* (54); *6865, 10079, 10870* (56a); *7692* (57b); *8616* (58); *10440* (60).
Heller, A. A. & E. G. *3778* (36); *3750* (51).
Heller, A. A. & P. B. Kennedy. *8722* (56).
Heller, G. C. — (4).
Henderson, L. F. *3948* (20); *3743, 8844* (22); *5122* (51); *8849* (52a); *2714* (56).
Henry, W. A. — (21).
Heriberto, Bro. *23, 137* (19).
Herrera, F. L. *1066, 1366, 1529* (3).
Herrick, C. L. *893* (27); — (36).
Herrin, A. — (22).
Hiatt, O. — (54).
Hillman, F. H. — (53).
Hitchcock, A. S. *40317* (5); —, *674, 675, 676, 677, 1366* (16); —, *20053* (19); *175* (20); *176, 177* (21); *572, 651, 721* (22); — (34); *9, 16½* (37a); *542* (56).
Hoffmann, R. — (57b).
Holm, T. — (21).
Holstein, G. W. — (13); — (21); — (34).
Holway, E. W. D. — (36).
Holway, E. W. D. & M. M. *540, 819* (5).
Hooker, — (4).
Hooker, W. J. — (22).
Hopkins, — (22).
Horner, R. M. *213* (22).
Hough, W. *19* (37a).
Howell, A. H. *189* (20); *135* (21); *153* (34).
Howell, J. T. *3048, 7940, 8005* (22); *7799* (23); *3606* (32); *4872* (52a); *5903, 5948* (52b); *3916* (53) *2642, 3749, 6577, 6589* (54); *3917, 7177* (56); *7188* (56a); *7908* (56b); *4935* (57b); *1900, 6715* (58); *4947* (60a); *3510* (61).
Howell, T. J. — (22).
Hubbard. *16* (21).
Imler, R. H. *49* (20).
Jaeger, E. C. —, *1168* (22); — (37a); *918* (51); *816* (55).
Jepson, W. L. — (22).
Jermy, G. —, *164* (13); — (34).
Johnston, E. L. *133* (20); *743* (36); — (51a).
Johnston, E. R. — (22).

Johnston, I. M. *3156, 3337, 3604, 4171, 4257* (15); *1755, 6458* (52a); *2059* (53a); —, *2051* (54); *1602* (56); *2306* (57); *4229* (59a); *6526* (60a).
Jones, M. E. *25661* (13); *2307, 24308* (15); —, *4308, 24963* (18); —, *22339* (19); *661* (21); —, *1462, 5609, 6002t* (22); *5631* (25); — (27); *5472* (30); —, *25020* (31); — (32); —, *3758* (36); — (37); —, *25662* (37a); *6054* (39); —, *5263* (41); — (43); — (44); *50451, 5422c* (51); — (51b); *3487* (52); *3133* (52a); —, *3871* (53); — (54); *2729* (55); *1461, 5622* (56); *220* (56a); *6324* (56b); *3900, 5116* (57a); —, *3824, 5029ak* (60); — (61).
Joor, J. F. — (13).
Jörgensen, P. *1600* (12).
Joseph, Bro. Claude. *2929* (33).
Jussel, M. S. — (22).
Kammerer, A. L. *49* (36).
Kearney, T. H. *103* (36).
Keck, D. *1111* (56).
Kellerman, W. A. — (13); — (34).
Kellogg, A. & W. G. Harford. *292* (56).
Kellogg, J. H. — (13).
Kelley, J. — (22).
Kelsey, F. D. — (22).
Kennedy, E. *47* (22).
Kennedy, P. B. *679* (22); —, *7092* (36); *1640* (53); *1775* (56).
Kennedy, P. B. & L. N. Goodding. *40* (24).
Kennedy, W. M. *35* (52).
Killip, E. P. & A. C. Smith. *14042* (19).
Kirkwood, J. E. *1212* (22).
Kleeberger, J. R. *199* (21).
Knechtel. *757* (4).
Knowlton, F. H. — (20); *165* (21); — (22); *286* (39).
Kramer, J. *201* (20); *166* (21).
Kreager, F. O. *529* (22); *115* (56).
Kuntze, O. — (3); — (8); — (12); — (33); — (36).
Kurtz. *3491* (48).
Lake & Hull. — (22).
Lambert, E. — (13).
Lamson-Scribner F. *59, 60* (22).
Langlasse, E. *704* (19).
Larsen, E. L. *167* (20).
Lawrence, W. E. *1028* (22); *1092* (51).
Leavenworth. — (13).
Lee, H. — (13); — (20).
Lehmann. *7944* (2).
Leiberg, J. B. *886, 1320, 2633* (22); *5798* (37a); *5806* (39); *136* (51a); *328* (51b); *3382* (54); *188* (56a).
Lemmon, J. G. —, *257* (22); —, *113* (31); *95* (53); *258* (60).
Lemmon, J. G. & Mrs. Lemmon. *258* (61a).
Leonard, E. C. *3457, 3612, 7079, 8478* (19).
Leonard, E. C. & G. M. *12714, 13792* (19).
Letterman, G. W. — (13); *140, 171* (20); —, *169* (21); *138* (33).
Liebmann, F. M. *94* (4).
Lighthipe, L. H. *8431* (16).
Lindheimer, F. *143, 396, 816* (13); *396* (14); *389, 815* (34).
Long, F. *45* (61).
Loomis, H. F. *1149* (51).
Lorentz, P. G. — (19); *43a* (33).
Lossen, W. *163* (8); *293* (33).
Low, O. — (36).
Lunell, J. — (22).
Macbride, J. F. *3215* (6); *865* (51b).
Macbride, J. F. & Featherstone. *1296* (3); *130* (6).
Macbride, J. F. & E. B. Payson. *817* (54); *3384* (56b).
MacBride, T. H. — (21).
MacElwee, A. — (13).
Mackenzie, K. K. *233* (13).
Macoun, J. *10650* (20); — (23).
Maltby, F. S. *224* (36).
Mandon, G. *621* (5).
Marsh, C. D. — (21).
Marshall, W. F. *1213* (21).
Martin, — (20).
Martindale, I. C. — (36).
Mathias, M. E. *489* (39).
Matthes, B. *392* (14).
Matthews. *596* (6).
McIntosh. *504* (13); *510* (21).
McLean, T. R. — (6).
McQuarrie. — (37a).
Mearns, E. A. *2333, 2357, 2514, 2754, 2825, 3289* (20); *1259, 1541, 2346, 2356, 2761, 3652* (22); *69, 827, 1945* (36); *2252* (56).
Meehan, T. — (16); — (21).
Meredith, H. B. — (16).
Merrill, E. D. *451* (22).

Merrill, E. D. & E. N. Wilcox. *840* (51).

Metcalfe, O. B. *1364* (18); *1045* (36); *450* (39); *51* (51).

Michener, C. A. & F. T. Bioletti. — (55).

Mille, L. *271* (19).

Milligan, J. M. — (36).

Mills, L. *8* (60).

Mohr, C. *144* (14).

Moldenke, H. *256* (16).

Moore, — (22).

Moore, J. A. & J. A. Steyermark. *3275* (37a).

Moritz, *1595* (19).

Mowry, H. W. — (37a).

Moyer, I. S. — (13).

Moyer, L. R. *2520* (20).

Müller, F. *1088* (4).

Mulford, A. I. — (21); —, *169, 287* (22); *1233* (36); *288* (56a).

Munson & Hopkins, — (27).

Munz, P. A. *7679* (22); *5113* (52); *2555, 7004, 9596* (52a); *11073* (53); *6799* (53a); *6749, 9416* (54); *8987, 9157* (55); *8293* (56).

Munz, P. A. & R. D. Harwood. *3580* (36); *3461* (51); *3649* (51b); *3703, 3796* (54); *3639* (60); *3639* (61).

Munz, P. A. & C. L. Hitchcock. *10955* (32).

Munz, P. A. & D. Keck. *4974* (55); *4886* (57); *7847* (60a).

Murdock, J. *4804* (36); *4771* (39).

Nealley, G. C. —, *122* (13); *660* (14); *659* (18); *703* (27); *156* (33); *658* (34).

Nelson, A. —, *439, 8329* (13); *486, 2456, 3019, 8074, 8549* (20); —, *338, 1470, 8408* (21); *678, 10117* (22); *8620* (36); *3989* (37); *1662, 7634, 8066, 9798* (38); *1470, 8069* (39); *8339* (51); *1375, 1455* (56); *9408* (56a) *2454, 8552* (56b).

Nelson, A. & J. F. Macbride. *1164* (22); *1248* (56a).

Nelson, A. & R. *6000* (22); *6006* (56); *6013* (56b).

Nelson, E. W. *2089* (1); *1592, 1837* (4); *1661* (19); *1554* (22); *6323* (36).

Nelson, E. W. & E. A. Goldman. *7508* (15).

Newberry, J. S. — (22); — (61).

Newsom, V. — (53); — (53a).

Nicolas. — (17).

Nicolas & Arsène. *35* (4).

Nicollet, I. N. & C. A. Geyer. *206* (20).

Norton, J. B. —, *174* (13).

Nuttall, T. — (13); — (22); — (34); — (37); — (53).

Orcutt, C. R. *3622, 4296, 4420* (4); *5940* (14); *4531, 4534* (19); *2108, 2118, 2285* (22); *102* (52a); *1357* (59a).

Orcutt, C. R. & Fish, — (54).

Orrok, G. A. — (16).

Ortega, J. G. *4773* (19).

Oslo, E. *439* (19).

Osterhout, G. E. *3154* (13); *2204* (20); —, *2320 2321, 2488, 2917* (21); *3562* (27) *2113, 2663* (29); *2203, 5757* (36); *2110, 2268, 2664, 5796* (39).

Otis, I. C. *845, 1081* (22).

Over, W. H. *15843, 16996* (21).

Overmann, D. — (22).

Oyster, J. H. —, *2800* (13); *2801* (20).

Pace, L. *436* (21).

Pachano, A. *79* (3).

Palmer, Ed. *352, 353, 357, 485, 600* (4); *404, 648* (14); *57, 254, 402, 831* (15); *181* (16); *351, 484* (18); *484, 101* (19); — (21); *170* (22); —, *248, 358, 480* (36); *45, 359* (37a); *171* (41); *578* (51); *36* (51b); *46* (53); *32* (54); *2574* (56); *157* (57); *591, 712* (59b); *173* (60); *598* (61).

Palmer, E. D. *3* (22).

Palmer, E. J. —, *1099, 2356, 3004, 3200, 3986, 6043, 6327, 10417, 11800, 13697, 13988, 14249, 31003* (13); *10205, 10786* (14); *13072, 14562* (20); *10058, 12603, 13048* (21); *30976* (33); *10092* (34); *31146* (36).

Pammel, L. H. *25* (20); — (33).

Pammel, L. H. & R. E. Blackwood. *3749, 4046* (22).

Parish, S. B. — (22); *10063* (32); *3314* (51); *3312* (52a); *3486, 4775, 7105* (54); — (60a); — (61a).

Parish, S. B. & W. F. *159* (22); *214, 214a* (54); *629* (56); *210* (61a).

Parry, C. C. — (13); — (14); *81* (34); — (37a); *78* (41); *76* (42); *210* (61).

Parry, C. C., J. M. Bigelow, C. Wright & C. Schott. *387* (18).
Parry, C. C. & E. Palmer. *257* (4).
Patterson, H. N. — (21); — (22); —, *41* (27); *210* (36); — (39); *209* (56); *210* (56b).
Payson, E. B. *2323* (27); *332* (36); *1094* (39).
Payson, E. B. & G. M. Armstrong. *3315* (56).
Payson, E. B. & L. B. *3081, 4425* (22); *3930* (27); *3862* (36); *2309, 3831* (40); *1757* (56).
Peale, — (16).
Pearce, R. *111* (6).
Pearson, E. *279* (20).
Pearson, E. & D. *70* (51).
Pearson, G. A. *39* (37).
Peck, M. E. *9743, 13682* (22).
Peckham, S. F. — (54).
Peebles, R. H. & G. J. Harrison. *4730* (19); *4737* (36); *5049* (61).
Peebles, R. H., G. J. Harrison & T. H. Kearney. *397, 4668* (18); *440* (36); *4955* (37a); *5170* (51); *1239* (51b); *5164* (57a).
Peebles, R. H. & H. F. Loomis. *6731* (57a).
Peirson, F. W. *121, 7550* (22); *9200, 752* (31); *7765, 9824* (32); *9809* (36); *00, 9894* (44); *751, 9836* (51); *9862* (52a); *119, 2302, 2465, 4450* (54); *750* (58); *7209* (60a).
Pennell, F. W. *13069* (5); *14472, 14568* (6).
Philippi, R. A. — (10a); — (33); *734* (50).
Piemeisel, R. L. *3481* (61a).
Piper, C. V. — (22); *2682* (51).
Pittier, H. *826, 1761, 2209, 4793, 7350, 9027, 10352* (19).
Plaskett, R. A. *165* (22).
Platt, W. B. — (22).
Pond, R. H. — (13).
Pringle, C. G. *616, 9802* (4); —, *633, 1077* (18); — (22); —, *737, 9803* (36); — (61).
Prior, A. — (19).
Purpus, C. A. —, *4892* (4); *4930* (11); *4620* (13); *62* (15); *6190* (22); — (27); *6032* (28); *6349* (31); *6507* (36); *4535, 8071, 8091* (37a); *6144* (41) *6192* (42); *5498* (52); *80* (52a); *5286* (53a); *5102* (56); — (61).
Ramaley, F. *1397* (39).
Ramaley, F. & W. W. Robbins. *3578* (56).
Redfield, J. H. — (20); *464* (21); *121* (22).
Reed, E. L. *3241* (20).
Reed, F. M. *5240* (54).
Rehn, J. A. Q. & H. L. Viereck. — (36).
Reinhardt, G. F. — (22).
Reko, B. P. *4228* (14).
Reverchon, J. *323* (13); *1650* (14); —, *325, 959A* (20); —, *324, 3836* (21); —, *959B, 322* (34); *3103* (36).
Reynolds, C. A. *159* (22).
Rhodenbaugh, E. F. *12* (22).
Robbins, W. W. *2534, 2572* (21); *8235* (29).
Rose, J. N. *18081* (14); *2457, 2896* (19); *118* (22); *16152, 16230* (59b).
Rose, J. N. & W. R. Fitch. *13069, 17083* (21); *17555* (36).
Rose, J. N. & R. Hay. *5876* (4).
Rose, J. N. & J. H. Painter. *7734* (4); *7071, 7549* (19).
Rose, J. N., J. H. Painter & J. S. Rose. *9444, 9595, 9831* (4); *10017* (14).
Rose, J. N. & G. *22198* (5).
Rose, J. N., P. C. Standley & P. G. Russell. *15085* (36).
Rose, L. S. — (22).
Rothhammer, L. N. *508* (20).
Rothrock, J. T. — (16); *642* (18); *281* (22).
Runyon, R. *997* (4); *583* (14).
Rusby, H. H. *139* (18); *612, 613* (36); *614* (39); *138, 611* (52a).
Russell, C. — (13).
Rust, H. J. *181* (22); *640* (51).
Ruth, A. *1204* (21); *1288* (34).
Ruth, E. C. *1150* (20).
Rydberg, P. A. *713* (20); —, *123, 714, 1689* (21); *1236* (34).
Rydberg, P. A. & E. A. Bessey. *4545* (20); *4546* (22); *4544* (56).
Rydberg, P. A. & E. C. Carlton. *6960* (22).
Rydberg, P. A. & A. O. Garrett. *9862* (51).
Rydberg, P. A. & R. Imler. *1086* (13); *912* (21).

Rydberg, P. A. & F. K. Vreeland. *5769* (51a).
Safford, W. E. — (20).
Sandberg, J. H. — (20); — (22); — (56a).
Sandberg, J. H. & J. B. Leiberg. *378* (22); *160* (51); *519* (56).
Sandberg, J. H., J. B. Leiberg & A. A. Heller. *1033* (20); *651* (22); *144* (56).
Sanford, J. A. *173* (22).
Saunders, C. F. — (36).
Savage, T. E., J. E. Cameron & F. E. Lenocker. — (22).
Schaffner, J. G. *110*, *199* or *169* (4).
Schedin, L. N. & N. T. — (20).
Schellenger, E. E. *1* (61a).
Schickendantz, F. *250* (10).
Schenitz, — (4).
Schmoll, H. M. *1488* (39).
Schmoll, H. M. & D. Nusbaum. *1647* (51a).
Schoenfeldt, L. *3069* (59a).
Schott, A. — (13); *41*, *861* (18); — (36); *1* (61).
Schulz, E. D. *376* (13); *573* (21); *215* (34); *227* (37a).
Shafer, J. A. *10557*, *13738* (19).
Sharp, S. S. *380* (20).
Shear, C. L. *67* (13); *3692* (36); *4810* (37).
Shear, C. L. & E. A. Bessey. *5290* (29); *4036* (56b).
Sheldon, C. S. *231* (13); *426* (21); *20*, *104*, *425*, *427* (36).
Sheldon, E. P. *8182* (22).
Shockley, W. H. *227* (24); *304* (53).
Shreve, F. — (60a); —, *5848* (61).
Siler, A. — (22); — (41).
Simpson, J. H. — (16); — (20).
Sinsheimer, J. — (22).
Sintenis, P. *2693*, *5620* (19).
Skehan, J. *115* (36).
Skinner, S. A. *215* (20); *215a* (21).
Small, J. K. — (16).
Small, J. K. & J. J. Carter. —, *286*, *676* (16).
Smart, D. L. *119* (51b).
Smith, B. H. — (21); — (39).
Smith, C. L. *827* (14).
Smith, C. P. *1961* (22); *1709* (56).
Smith, E. C. —, *102* (20); —, *98* (22).
Smith, G. — (21).
Smith, H. H. *477* (19); *5054* (54).
Smith, I. R. *3246* (22).
Smith, L. E. *452* (22).
Smith, R. H. — (20).
Smith, R. J. — (22).
Smyth, B. B. *272* (13); *274*, *299* (20); *147*, *307* (21).
Snodgrass, R. E. & E. Heller. *614*, *689*, *719* (19).
Snow, F. H. — (21).
Sonder, W. *1595* (19).
Sonne, C. P. *426* (22); *117* (56a).
Soth, M. E. — (22).
Spencer, M. F. *1266* (22); *1941* (32); *1143* (54); *1815* (58); *1143* (61); *1990* (61a).
Spiegelberg, C. H. *4* (22).
Spruce, R. *4922*, *6463* (19).
Standley, P. C. *9400*, *40738* (13); *12787* (16); *25256*, *25350*, *26360*, *28333*, *31521*, *32150* (19); *40294* (27); —, *6254* (36); *7272*, *40331* (37a); *4400*, *5221*, *8094*, *13906* (39); *17667* (56b).
Starz, E. — (20).
Stason, M. — (61a).
Stearns, E. *58* (13).
Stelzner. *9755* (49).
Stevens, G. W. *1714*, *1765*, *2843* (21); *1161* (34).
Stevens, W. C. — (13).
Steward, A. N. — (22).
Stewart, A. *2083*, *2084*, *2085*, *2086*, *2087* (19).
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## Explanation of Plate

### PLATE 4

Fig. 1. Outer petaloid stamen of *Mentzelia aspera.* × 7½.

Fig. 2. Inner stamen of *Mentzelia aspera.* × 7½.

Fig. 3. Petal of *Mentzelia aspera.* × 3.

Fig. 4. Capsule of *Mentzelia aspera,* showing calyx-lobes breaking away from the calyx. × 1½.

Fig. 5. Capsule of *Mentzelia aspera.* × 3.

Fig. 6. Embryo and surrounding endosperm of *Mentzelia aspera.* × 7½.

Fig. 7. Seed of *Mentzelia aspera.* × 3.

Fig. 8. Seed of *Mentzelia adhaerens.* × 7½.

Fig. 9. Seed of *Mentzelia arborescens.* × 7½.

Fig. 10. Epidermal hairs of *Mentzelia asperula* (camera-lucida drawing).

Fig. 11. Petal of *Mentzelia albicaulis.* × 1.

Fig. 12. Inner stamen of *Mentzelia laevicaulis.* × 1.

Fig. 13. Outer stamen of *Mentzelia laevicaulis.* × 1.

Fig. 14. Seed of *Mentzelia reflexa.* × 7½.

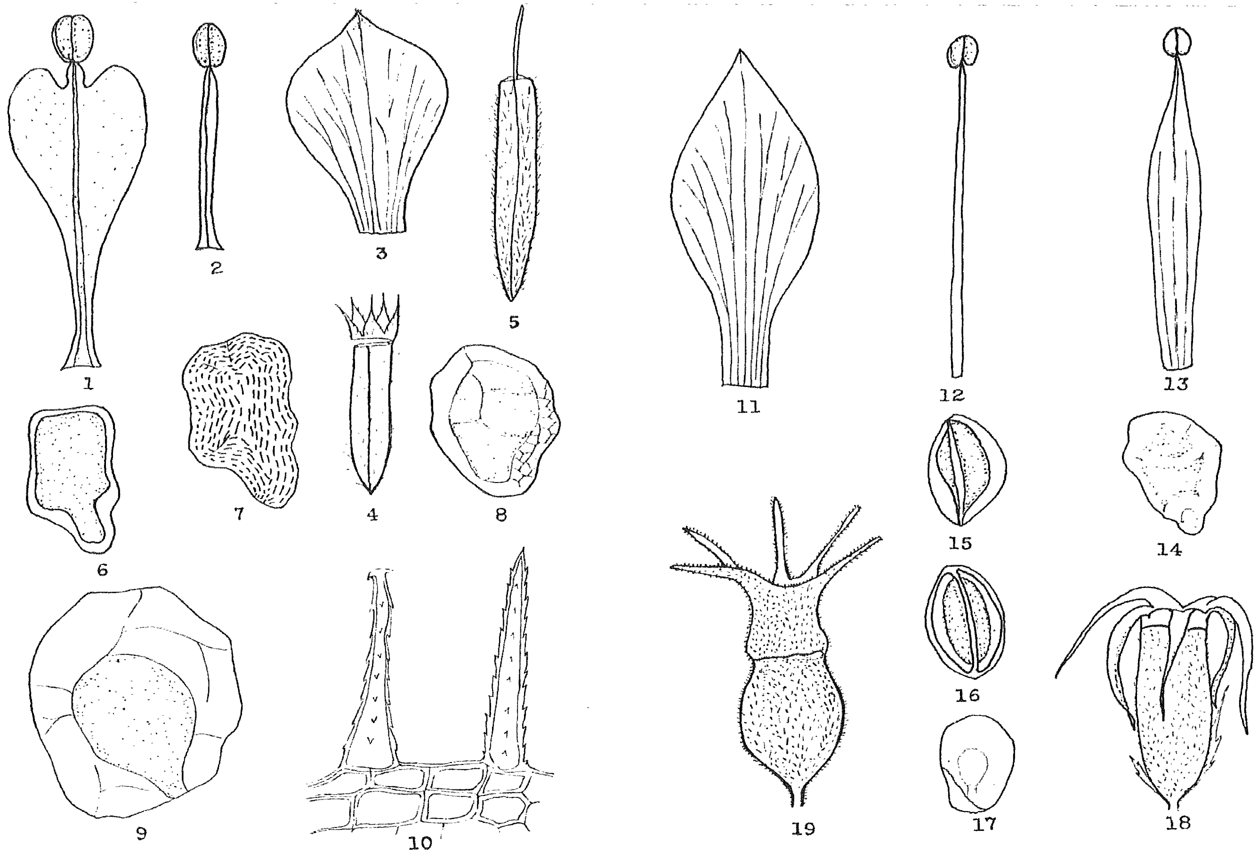
Fig. 15. Seed of *Mentzelia Torreyi.* ×7½.

Fig. 16. Seed of *Mentzelia Torreyi.* × 7½.

Fig. 17. Seed of *Mentzelia laevicaulis.* × 7½.

Fig. 18. Capsule of *Mentzelia laevicaulis.* × ⅔.

Fig. 19. Capsule of *Mentzelia Torreyi.* × 3.

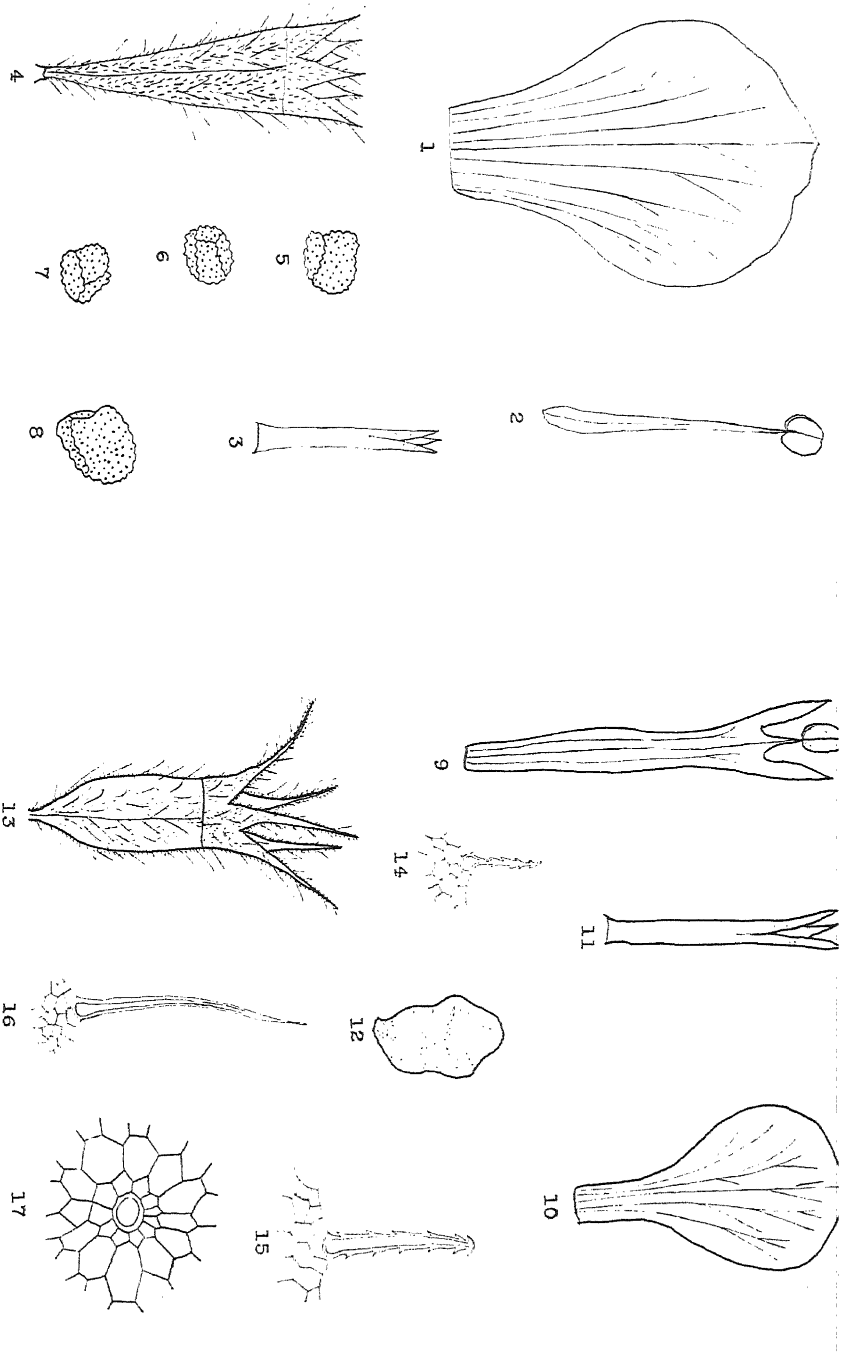


DARLINGTON—MONOGRAPH OF MENTZELIA

## Explanation of Plate

### PLATE 5

Fig. 1. Petal of *Mentzelia albicaulis.* × 7½.
Fig. 2. Stamen of *Mentzelia albicaulis.* × 7½.
Fig. 3. Showing stigmatic surfaces of the style of *Mentzelia albicaulis.* × 7½.
Fig. 4. Capsule of *Mentzelia albicaulis.* × 3.
Figs. 5–8. Seeds of *Mentzelia albicaulis* from different angles. × 7½.
Fig. 9. Stamen showing bicuspidate apex of *Mentzelia tricuspis.* × 7½.
Fig. 10. Petal of *Mentzelia tricuspis.* × 2.
Fig. 11. Style showing stigmatic surfaces of *Mentzelia tricuspis.* × 2.
Fig. 12. Seed of *Mentzelia tricuspis.* × 3.
Fig. 13. Capsule of *Mentzelia tricuspis.* × 1½.
Figs. 14–16. Showing pubescence of *Mentzelia tricuspis* (camera-lucida drawing).
Fig. 17. Epidermal surface showing cellular structure at base of hair of *Mentzelia tricuspis* (camera-lucida drawing).



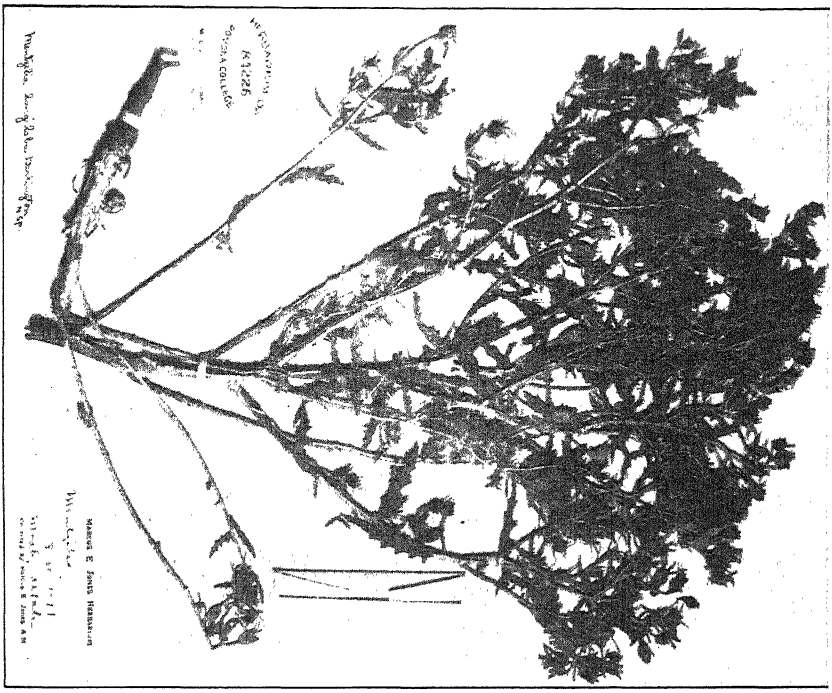
DARLINGTON—MONOGRAPH OF MENTZELIA

## EXPLANATION OF PLATE

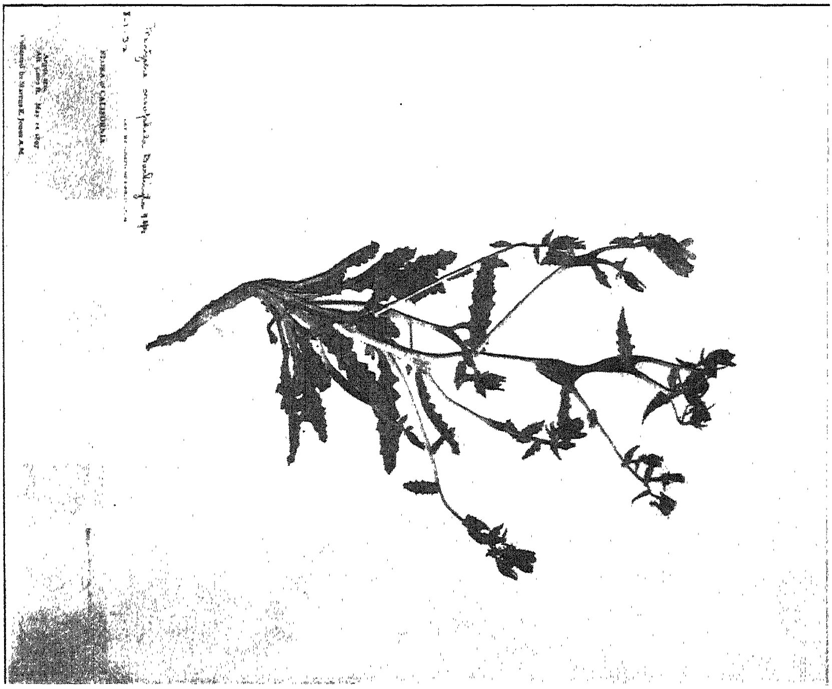
### PLATE 6

Fig. 1. *Mentzelia longiloba* Darlington. From specimen, *M. E. Jones,* in the Herbarium of Pomona College.

Fig. 2. *Mentzelia oreophila* Darlington. From the type specimen, *M. E. Jones,* in the Missouri Botanical Garden Herbarium.


Mentzelia longiloba Darlington n.sp.
MARCUS E. JONES HERBARIUM
Collected by MARCUS E. JONES A.M.

1



2

DARLINGTON—MONOGRAPH OF MENTZELIA

# STUDIES IN GRINDELIA. I[1]

## New Species, Varieties, and Combinations of Grindelia

JULIAN A. STEYERMARK

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In the course of an extended critical monographic study of the genus *Grindelia,* it has been found necessary to describe a number of new species, varieties, and forms, in addition to making new combinations. The following represent a part of such novitates, which will be elaborated and discussed in more detail in a future publication concerning the entire genus.

**Grindelia squarrosa** (Pursh) Dunal var. **serrulata** (Rydb.) Steyermark, comb. nov.

*G. serrulata* Rydb. in Bull. Torr. Bot. Club **31**: 646. 1904.

**Grindelia rubricaulis** DC. var. **bracteosa** (Howell) Steyermark, comb. nov.

*G. bracteosa* Howell in Madroño **2**: 22. 1931.

**Grindelia rubricaulis** DC. var. **robusta** (Nutt.) Steyermark, comb. nov.

*G. robusta* Nutt. in Trans. Amer. Phil. Soc. N. S. **7**: 314. 1841.

**Grindelia rubricaulis** DC. var. **latifolia** (Kellogg) Steyermark, comb. nov.

*G. latifolia* Kellogg in Proc. Cal. Acad. **5**: 36. 1873.

**Grindelia rubricaulis** DC. var. **platyphylla** (Greene) Steyermark, comb. nov.

*G. robusta* Nutt. var. *platyphylla* Greene, Pitt. **2**: 289. 1892.

**Grindelia rubricaulis** DC. var. **elata** Steyermark, var. nov., caulibus supra valde corymbifere ramosis, ramosculis floriferis elongatis adscendentibus valde divaricatis, glabris, 6–12 dm. altis; foliis in ramosculis floriferis plerumque reductis et

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[1] Issued April 12, 1934.

adversum capitulos multum parvioribus, omnibus firmiter membranaceis vel subcoriaceis, grosse remote vel crebre dentatis vel serratis, dentibus latis acutis vel triangularibus saliente acuminatis vel parce serratis, foliis caulinis principalibus mediis et inferioribus 3.5–7.5 cm. longis, 0.7–1.8 cm. latis, 3–9 plo longioribus quam latioribus, lineari vel anguste oblongis vel oblanceolatis vel oblongo-lanceolatis, acutis vel obtusis, ad basem plerumque angustatis, illis in ramosculis floriferis 1–2.3 cm. longis, 0.2–1 cm. latis, plerumque 1½–3 plo longioribus quam latioribus, ovatis vel ovato-lanceolatis vel lanceolatis, acutis vel acuminatis, valde amplexicaulibus, omnibus glabris; involucro abundanter resinosissimo 6–7 seriato, bracteis valde reflexis vel revolutis, extremis plerumque congestis, subteretibus, subcoriaceis; ligulis 8–12 mm. longis; aristis plerumque 2.—Collected on clay hills, 7 miles southwest of Simi, Ventura Co., California, May 29, 1931, *J. T. Howell 6574* (Cal. Acad. Sci. Herb. No. 188491 TYPE, Mo. Bot. Gard. Herb. photograph).

**Grindelia camporum** Greene var. **australis** Steyermark, var. nov., caulibus 3–7 dm. altis, glabris, supra subcorymbifere vel subpaniculate ramosis, ramosculis floriferis brevibus crebre adscendentibus saepe prope summas ramosculorum congestis; foliis valde resinoso-punctatis, omnibus foliosis, subcoriaceis, foliis caulinis principalibus mediis et superioribus 3–7 cm. longis, 1–2.5 cm. latis, 2–4 plo longioribus quam latioribus, oblongis vel ovato-oblongis vel ovatis, apice apiculatis, valde amplexicaulibus, saepe saliente denticulatis vel spinuloso-denticulatis, dentibus brevibus, basibus latis, apicibus acutis vel spinulosis; disco 1–1.3 cm. alto, 1.2–2 cm. lato; involucri bracteis valde reflexis vel valde recurvatis vel revolutis.—Collected at base of dry slope, 3 miles east of Elizabeth Lake, Los Angeles Co., California, Sept. 4, 1928, *P. A. Munz & I. M. Johnston 11157* (Pomona Coll. Herb. TYPE).

**Grindelia camporum** Greene var. **abbreviata** Steyermark, var. nov., caule glabro; foliis subcoriaceis, abundanter resinoso-punctatis, ut videtur lucidis, adversum capitulos reductis; disco parvo, 0.8–1 cm. alto, 1–1.2 cm. lato; involucri bracteis brevibus, 2–8 mm. longis, apicibus brevibus, 1.5–2.5 mm. longis, paullo patentibus vel adscendentibus; aristis circiter 4 mm. longis.—Collected on alkaline flats, Lancaster, Los Angeles Co., Sept. 23, 1927, *Hoffmann* (Herb. Santa Barbara Mus. TYPE).

**Grindelia hirsutula** Hook. & Arn. var. **subintegra** Steyermark, var. nov., caulibus et foliis plus minusve puberulis; foliis integris vel subintegris; involucri bracteis apicibus erectis vel adscendentibus, glabris.—Collected on grassy hillside, 2 miles east of Ojai, Ventura Co., July 1, 1933, *J. T. Howell 11414* (Mo. Bot. Gard. Herb. No. 1044105 TYPE, Cal. Acad. Sci. Herb. isotype); dry field, Ojai, Ventura Co., June 4, 1927, *Hoffmann* (Herb. Santa Barbara Mus.).

**Grindelia Hallii** Steyermark, sp. nov., caulibus tenuibus, 2.5–6 dm. altis; foliis subcoriaceis, abundanter et conspicue resinoso-punctatis, serrulatis vel saliente serratis vel integris, foliis caulinis mediis et inferioribus 2.5–7.5 cm. longis, 0.7–1.2 cm. latis, 3½–7½ plo longioribus quam latioribus, oblongis vel oblongo-oblanceolatis vel oblongo-lanceolatis, foliis caulinis superioribus et illis in ramosculis floriferis oblongo-lanceolatis vel lanceolatis; capitulis parvis, 1.5–2 cm. latis; disco parvo, campanulato-hemispherico, 0.7–1 cm. alto, 0.8–1.7 cm. lato; involucro abundanter resinoso, involucri bracteis exterioribus et mediis apicibus brevibus erectis, adscendentibus, patentibus vel paullo reflexis acutis vel acuminatis, 2–8 mm. longis, lanceolatis vel lineari-lanceolatis; ligulis 10–20, 8–9 mm. longis, 2–3 mm. latis; achaeniis 4.5–5 mm. longis, circiter 2 mm. latis, laevibus vel sulcatis, apice uni-dentato vel oblique truncato; aristis tenuibus, integris, 2.5–4 mm. longis, ½–¾ (plerumque ½–⅔) longitudinem disci floris aequantibus.—Collected in open meadows about Cuyamaca Lake, San Diego Co., California, June 30, 1903, *L. R. Abrams 3957* (N. Y. Bot. Gard. Herb. TYPE, Gray Herb., Mo. Bot. Gard. Herb., Field Mus. Herb., and Pomona College Herb., isotypes).

**Grindelia arenicola** Steyermark, sp. nov., caulibus prostratis e basi sublignea vel herbacea tenue, ramosculis floriferis supra laxe corymbifere divaricateque ramosis vel ramosculis elongatis simplicibus monocephalatis, glabris, 3–5 dm. altis; foliis firmis vel subcoriaceis, abundanter et plus minusve valde resinosis, foliis caulinis principalibus saliente serrulatis, serratis vel dentatis saepe modo supra medium vel circiter apicem, illis in ramosculis floriferis saepe infra capitulos reductis congestis et integris, foliis caulinis principalibus mediis et inferioribus 3–6 cm. longis, 0.8–2 cm. latis, 3–4 plo longioribus quam latioribus, spatulatis vel oblongo-vel oblanceolato-spatulatis, plerumque obtusis, foliis radicalibus vel basilaribus cuneatis vel obovato-cuneatis, apice obtusis vel subtruncatis; disco 0.8–1.2 cm. alto, 1.2–2 cm. lato; involucro abundanter et valde resinoso, bractearum parte superiore laxe revoluta vel valde reflexa; ligulis 19–34, aureo-luteis, 11–14 mm. longis, 2.5–3 mm. latis; achaeniis 3–4.5 mm. longis, 1.3–1.6 mm. latis; aristis 3–5, plerumque moderatim serrulatis vel setuloso-serrulatis vel setulosis, 3–4.5 mm. longis.—Collected in swale-like hollows in sand dunes, Mendocino Coastal plain, 4.5 miles north of Ft. Bragg, Mendocino Co., California, Sept. 14, 1930, *J. T. Howell 5473* (Cal. Acad. Sci. Herb. No. 187937 TYPE, Univ. Cal. Herb., Gray Herb. and Mo. Bot. Gard. Herb., isotypes).

Annals
of the
Missouri Botanical Garden

VOL. 21 APRIL, 1934 No. 2

# PROTOGASTER, REPRESENTING A NEW ORDER OF THE GASTEROMYCETES[1]

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A most interesting Gasteromycete was discovered by the late Dr. Roland Thaxter at Kittery Point, Maine, August, 1895. Dr. Thaxter applied to this fungus the generic name, *Protogaster.* Its tiny subspherical fructifications were found from one to three inches below the surface of the ground, attached to or ''running from the roots of the cultivated pansy.'' In a letter to the writer under date of March 15, 1932, Dr. Thaxter said ''The fungus seems a very curious and interesting one. It appeared to be definitely a parasite on the roots of Viola.'' It is, indeed, an interesting Basidiomycete!

In one collection (*5661*) Dr. Thaxter had preserved intact a clod of soil glued to the bottom of a small pill box. Nestled in some of the crevices and hollows of the clod are groups of the basidiocarps of this fungus (pl. 7). Under the low-power binocular microscope these fructifications have the appearance of tiny cocoons of some insect or the egg-sacs of tiny spiders. They adhere to the soil or to roots by minute cobwebby hyphae which radiate in every direction from the sporophore. These

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[1] Published as Technical Paper No. 214 with the approval of the Director of the Oregon Agricultural Experiment Station.

Issued June 5, 1934.

are so numerous from the surface of very young fructifications that the surface of the latter is nearly obscured. In the more mature stages this indefiniteness becomes a more definite meshy surface. In pl. 7 such a group of sporophores in several stages of maturity is shown in close proximity to a small rootlet.

The three collections taken by Dr. Thaxter formed the basis of the studies here reported. The collections together total hundreds of the fructifications dried with some of the soil in which they were found. These gasteromycetous fruiting bodies are from 0.1 to 0.5 millimeter in diameter. The youngest ones are white, while the more mature individuals are pale brownish-drab, the surface being of a soft dry byssoid to innately fibrillose character. The loose hyphae of the surface of two or more fruiting bodies often intertwine, causing them to adhere to each other. When several are involved a bead-like series may result. This adherence, however, in all the observations made by the writer involves only the superficial hyphae of the peridium, and the internal structure remains entirely separate. Each of the bodies in these cases remains a morphologically distinct entity.

In order to study the morphology in detail several fructifications were prepared and microtome sections were made. They were put through the formal-acetic-alcohol fixative and stained with safranin-gentian violet. When saturated by a clear solution, such as formal-acetic-alcohol, the sporophores with immature spores changed merely to a creamy white, while the more mature ones having the glebal locule stuffed with spores changed immediately to a color very close to vinaceous-fawn.

The prepared slides and crushed mounts show the peridium to be a simple layer of meshy or loosely interwoven hyaline hyphae (prosenchyma) which are white to cream-colored (*sub lente*) and usually are considerably branched. The layer is 17–46 μ thick. This comprises the whole of the sterile tissue of the fruiting body except the subhymenial layer which is composed of compacted hyphae taking a deeper stain than the peridium or hymenium. This subhymenial layer is very thin, usually the thickness of two or three hyphae (2–4 μ thick).

The gleba is extremely simple, consisting of one spherical locule, the wall of which is a definite smooth hymenium composed of clavate to fusiform basidia interspersed among short-clavate paraphyses. The basidia are mostly 1–4-spored, 2-spored basidia predominating in young fruiting bodies. The basidia are 8.5–11 x 3–7 µ. In cases of large accumulations of spores at maturity the gleba in general appearance assumes a clay color or Mikado brown to snuff-brown. Where compact accumulations of spores are found the spore mass assumes a color darker than indicated above.

When considered in terms of the capacity of the locule, spores are produced in large quantities. At maturity the cavity is completely filled, and there is some indication that the pressure of the spores may burst the peridium, liberating the former. As a rule the peridium doubtless disintegrates in the soil, with spore dispersal by water and possibly by insects.

The spores are most commonly pip-shaped to obovoid, but are sometimes ellipsoid with broadly rounded ends. Under the microscope they are hyaline to dilute citrinous but in mass they are from clay color to Mikado brown or snuff-brown. The exospore is rather thick and distinct. The spores measure 8–12.5 x 3.5–6 µ.

This is doubtless the most simple gasteromycetous form yet discovered. The tiny subspherical sporocarps with subterranean origin and life cycle are very similar in fundamental tissues and ecological conditions (hypogeous) of development to those of the button stages (primordia) of the sporophores of more highly differentiated Gasteromycetes and angiocarpous Agaricales. The primordia of the sporocarps of the plurilocular Gasteromycetes and of the Agaricales for the most part have a hypogeous origin but further developmental stages, except for most of the Hymenogastrales, emerge to an epigeous stage at maturity. With such a recapitulation of this button-like hypogeous form in the primordial sporocarps of most of these higher fleshy fungi it would not be difficult to postulate the emergence of the epigeous forms among them from such simpler hypogeous forms as *Protogaster*.

The peridium of *Protogaster* represents all of the sterile tissue of the normal sporophore. It is a simple layer of undifferentiated prosenchyma of a rather loose mesh, the remains undoubtedly of the fundament of the developing fructification. This type of peridial structure perhaps should be interpreted as the most primitive "universal veil" or volvate tissue of the Gasteromycetes, and it can perhaps with equal truth be said to be the forerunner of the volva (blematogen) in the primordium of the angiocarpous development of certain of the Agaricaceae.

The mycelioid hyphae which radiate into the soil from the sporophore usually are not organized to any degree into rhizomorphic cords. Two, three, or four hyphae may twine loosely together to form a meshy strand, but they seem never to assume such a definite relation and close contact with each other as are maintained in an organized rhizomorph. Most, if not all, of the previously known Gasteromycetes have well-developed fibrils or rhizomorphs at the termination of certain of which the fructifications are borne.

A study of the dry herbarium material of the fungus under consideration gives little clue as to its orientation *in situ*. For the most part the fructifications are spherical or oblong, and there is *usually* no definite place of attachment discernible. In a very small percentage of basidiocarps studied there is a condition, however, which must not be overlooked in this connection. Out of twenty-seven fructifications which were studied critically, three showed the formation of a peg-like growth from the peridium into the locule. In each of these cases there was found a very inconspicuous place of attachment just below this exceptional peg-like growth. Sixty-eight additional specimens were examined *in toto* by transmitted light, by which two more were found with the growth. The peg-like growth is of the same loose structure as that of the peridium. It is not an invagination of the peridium but should doubtless be more properly interpreted as a mere tendency toward further sterile tissue. It is perhaps in fact a tendency toward a very rudimentary sterile base or even the rudiment of a columella. The one of these of which the writer has prepared microtome sections extends into the locule 67 μ and is 42 μ in diameter at the base. This particular fructification is 374 μ in diameter and the locule measures 292 μ in diameter. This rudimentary columella (?) or sterile base (?) is not a constant morphological character of *Protogaster* and thus it has not been incorporated in the formal description below.

All previously described Gasteromycetes are plurilocular and therefore involve many more sterile elements, such as plates and septa in the gleba, than found in *Protogaster*. Since *Protogaster* is so unique in its morphological simplicity and unilocular character of the gleba, a new order and family are proposed to include this genus. The new order is proposed to comprise all unilocular Gasteromycetes having no specialized sterile tissues, and the family to include all of those of the new order which show no invagination, have a definite even hymenium.

Dr. Thaxter gave the genus name, *Protogaster* (*in Herb.*), and in his search for a suitable specific name he had used three, to-wit, *P. rhizophilus, P. radicicolus,* and *P. Violae.* The writer has adopted the specific name which appears (*in Herb.*) on the collection having the lowest accession number. The diagnostic description follows:

### PROTOGASTRALES Zeller, ord. nov.

Fructificationes subsphaericae, sine speciale sterile textu; peridium indehiscens; gleba uniloculata.

*Fructifications* spherical to subspherical, with no specialized sterile tissues present; *peridium* simple, closed; *gleba* unilocular.

### PROTOGASTRACEAE Zeller, fam. nov.

Fructificationes subsphaericae, minutae; *peridium* simplex contextum, indehiscens; *gleba* uniloculata, sine invaginatione; hymenium laeve.

*Fructifications* small, subspherical; *peridium* of simple fundamental tissue, indehiscent; *gleba* unilocular, showing no invagination; *hymenium* smooth.

## PROTOGASTER Thaxter, gen. nov.[2]

Fructificationes minutae, sphaericae vel subsphaericae, sine speciale sterile textu, hypogeae; peridium simplex primordiale contextum, indehiscens; gleba uniloculata, sine invaginatione; hymenium laeve; sporae ellipsoideae vel subellipsoideae, laeves, hyalinae vel subcoloratae.

*Fructifications* small, spherical to subspherical, with no specialized sterile tissues, hypogeous; *peridium* of simple fundamental tissue, indehiscent; *gleba* unilocular, showing no invagination; *hymenium* smooth; *spores* ellipsoid to subellipsoid, smooth, hyaline to slightly colored.

### **Protogaster rhizophilus** Thaxter, sp. nov.

Fructificationes sphaericae vel ellipsoideae, 100–500 μ diametro, hypogeae, superficie arida, alba vel pallide brunneo-grisea, byssoidea vel innato-fibrillosa (sericea), unde hypoidei funiculi in soli evanescunt; peridium 17–46 μ crassitudine, simplex, byssoideum, ex hyphis tenuibus laxis undulatis; gleba uniloculata, "clay color," "Mikado brown," vel "snuff-brown";[3] locellus subglobosus, primo vacuus, maturitate sporis repletus; hymenium laeve; basidia inconspicua, hyalina, clavata vel fusoidea, mono- vel tetraspora, vulgo dispora, 8.5–11 x 3–7 μ, sterigmatibus brevibus; sporae subellipsoideae vel obovoideae, laeves, hyalinae vel dilute citrinae *sub lente, in massa* "Mikado brown" vel "snuff-brown," exosporo subconspicuo, 8–12.5 x 3.5–6 μ.

In terra inter radices vivas Violae, Kittery Point, Maine, Amer. bor. (*Roland Thaxter*). Aestate.

Type: Kittery Point, Maine, August, 1895, *Roland Thaxter* (in Thaxter Bequest (No. 5660) to Farlow Herb., Harvard University).

*Fructifications* spherical to ellipsoid, 100–500 μ in diameter, hypogeous, held in soil cavities by cobwebby hyphae radiating in all directions from the peridium; *surface* white to pale brownish drab, dry, byssoid to innately-fibrillose (silky); *peridium* simple, of loosely interwoven hyphae mostly parallel with the surface, hyaline, 17–46 μ thick; *gleba* unilocular, from clay color to Mikado brown or snuff-brown due to accumulation of spores; *cavity* subglobose, empty at first but stuffed with spores at maturity; *hymenium* smooth; *basidia* inconspicuous, hyaline, granular, clavate to fusiform, 1–4-spored (2-spored predominate in very young fruiting bodies), 8.5–11 x 3–7 μ; *spores* pip-shaped, obovoid, or subellipsoid with broadly rounded ends, smooth, hyaline to dilute citrine (*sub lente*), Mikado brown to snuff-brown *en mass*, exospore rather prominent, 8–12.5 x 3.5–6 μ.

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[2] The writer assumes the whole responsibility for the description of the genus and species. Dr. Thaxter left no manuscript with the herbarium material and had published nothing pertaining to *Protogaster*.

[3] Ridgway's 'Color Standard and Nomenclature' was used throughout this paper.

One to three inches below the surface of the soil surrounding living roots of the cultivated pansy (*Viola*), Kittery Point, Maine (*Roland Thaxter*). August.

Specimens examined:

MAINE: York County, Kittery Point, August, 1895, *Roland Thaxter, 3282, 5660* (type), *5661* (in Thaxter Bequest to Farlow Herb., Harvard University).

Since the class, Gasteromycetes, is generally recognized as a grouping of several apparent series or lines of parallel or perhaps divergent tendencies in development, it cannot be considered as a natural single division of the fungi. For this reason it cannot be said that *Protogaster* is more primitive because of its greater simplicity than all forms exhibiting the several series of developmental tendencies in the previously described Gasteromycetes. Rather, it seems to take its place in one of the lines, namely, that with smooth ellipsoidal spores and with also a definite smooth hymenium. It seems to the writer that the most natural connection is from *Protogaster* through species of *Rhizopogon,* with their hypogeous nature, and finally through the Lycoperdales.

Connecting links may yet be discovered between *Protogaster* and *Rhizopogon.* And, too, other new forms may in time more definitely indicate the possible point or points of divergence of more primitive lines of development branching off from this main (?) trunk below *Protogaster.*

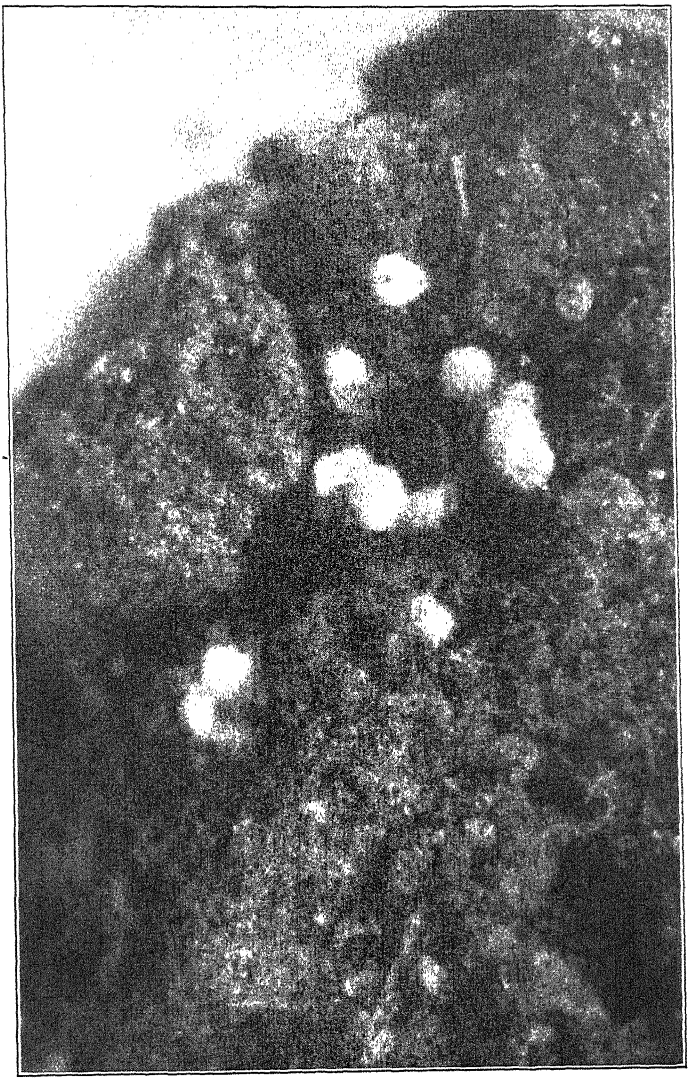
The writer is gratefully indebted to the late Dr. Roland Thaxter for the privilege of studying this most interesting fungus and to Professors J. H. Faull, W. H. Weston, Jr., and Oakes Ames, committee administering the Farlow Herbarium, for their cooperation in putting the herbarium material at his disposal.

## Explanation of Plate

### PLATE 7

*Protogaster rhizophilus* Thaxter

Sporophores in a crevice and hollow on the surface of a clod of soil taken 2 to 3 inches below ground, Kittery Point, Maine, August, 1895. (*Roland Thaxter*). About × 32. Photograph by Dr. Frank P. McWhorter.



ZELLER—PROTOGASTER

## Explanation of Plate

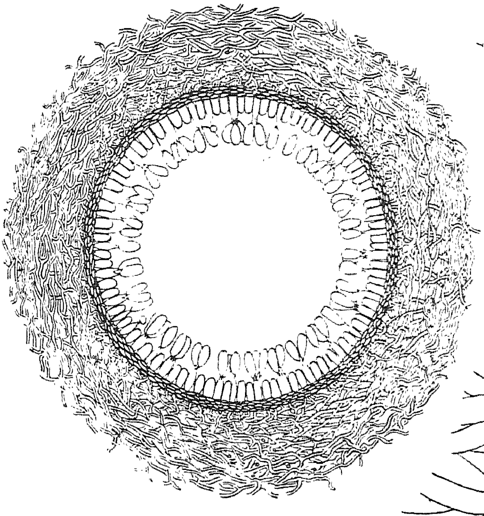
### PLATE 8

*Protogaster rhizophilus* Thaxter

Fig. 1. Diagrammatic median section of a basidiocarp, illustrating the relation of morphological parts. × about 300.

Fig. 2. Diagrammatic sketch of the peg-like growth of fundamental tissue rarely found to extend into the locule. × about 300.

Fig. 3. Drawing to scale of a section through the peridium and subhymenial layer, showing the relation to basidia and paraphyses, highly magnified. × about 3000.



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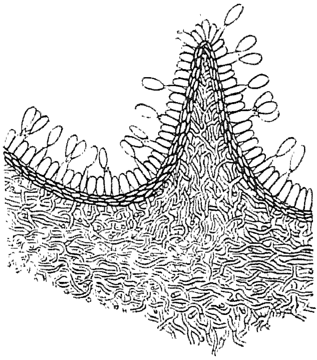

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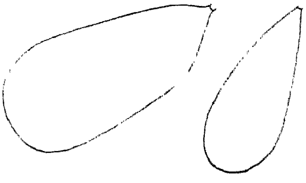

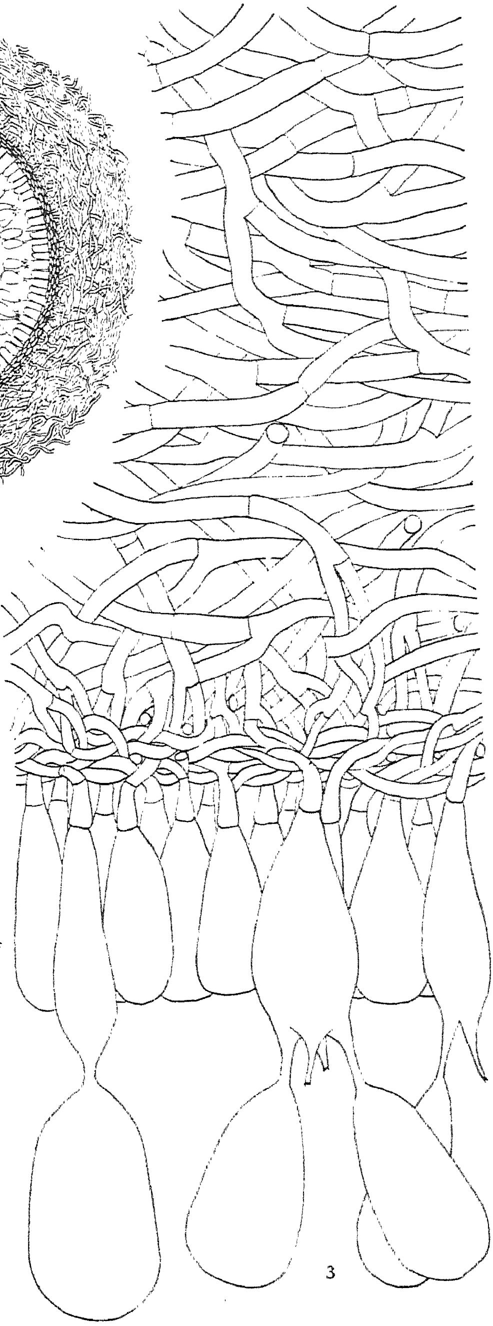

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ZELLER—PROTOGASTER

# CERTAIN PHYSICAL AND STRUCTURAL PROPERTIES OF THREE SPECIES OF SOUTHERN YELLOW PINE CORRELATED WITH THE COMPRESSION STRENGTH OF THEIR WOOD[1]

EARL E. BERKLEY

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There is a growing demand among lumber consumers for maximum strength values per unit volume of material and more reliable working stresses for structural timbers. This situation, allied with the rapid depletion of virgin growth timber, has made it difficult for the lumberman to meet the requirements of commerce without a more perfect knowledge of the factors influencing the strength and usability of wood than he has had in the past. Numerous researches, beginning with that of Parent about the year 1707, have been made on the mechanical properties of wood. Fernow ('92) summarized the earlier works, and the more recent investigations have been covered by The National Committee on Wood Utilization ('29) and by Withey and Aston ('30).

Defects in the form of knots and shakes have a definite effect upon the strength of beams, depending upon the size, condition, and position of the imperfections (Newlin and Johnson, '24). Spiral- and cross-grain have a decided effect upon strength and elastic properties, depending upon the angle at which the fibers lie in relation to the axis of the test stick (Wilson, '21).

The strength properties of clear wood have a certain relation to the specific gravity (density) regardless of species (Newlin and Wilson, '19, and Markwardt, '27), but it is readily observed

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[1] An investigation carried out jointly in the Graduate Laboratories of the Henry Shaw School of Botany and the Department of Civil Engineering of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

[2] A fellowship established by the American Creosoting Co.

Issued June 5, 1934.

that this relationship has definite limitations. For wood in general there may be a variation in compression strength of from 2000 to 3000 pounds per square inch for a given density. Wood taken from trees of the same species, and even from the same tree, has a variation of from 40 to 70 per cent (based upon the minimum strength) for a given specific gravity.

The purpose of this investigation on the wood of southern yellow pine was to determine the causes of these variations and if possible to describe them so that their presence might be recognized without first testing the material. It was found that the variations may be attributed to two sets of variables which, though interlocking, may be roughly outlined, as (1) the physical condition and chemical constituents of the cell wall, and (2) the anatomical structure of the wood. The physical conditions include the fiber-saturation point, the moisture content, the absolute density of the wood substance, and the percentage of resin affecting the specific gravity. Anatomical differences in the southern pines were the relative amounts of thick- and thin-walled fibers in a given area as determined by rate and type of growth, the size and distribution of resin ducts and wood rays, the length and diameter of the tracheids, and the structure of the cell walls. In evaluating the strength on the basis of structure, all specimens containing visible defects in the form of knots, checks, and shakes, and cross-grain of more than 1 in 25 were not used. A knowledge of the fiber-saturation point was necessary in order to eliminate moisture effects on strength. In addition, the specific gravity was corrected for benzol-soluble compounds in order to get the true relationship between the density and strength, since this was the most accurate measure of the relative mass of the different specimens. No attempt was made to study the chemistry of the cell wall.

## MATERIALS

The seven trees used in this study were selected by representatives of the American Creosoting Co., and the writer is indebted to these men for the data to be found in table I. Three species of southern yellow pine were included: *Pinus Taeda* L. (loblolly pine, trees 1, 2, 5, and 7), *Pinus echinata* Miller (shortleaf pine, tree 3), and *Pinus palustris* Miller (longleaf pine, trees 4 and 6).

One 32-ft. log was taken from the butt portions of trees 1, 2, 3, and 4, whereas three 8-ft. logs were taken in trees 5, 6, and 7, one at the butt, one from the top of the merchantable timber, and the third midway between the other two. In the latter group (trees 5, 6, and 7), note was made of the distance of each 8-ft. log from the stump. The seven logs collectively covered a range of 68 feet from the stump, so that the material was sufficient to make a comparative study of the distribution of strength throughout the merchantable timber.

Each of the logs was marked as to compass direction and tree number when cut, and samples of leaves and cones were collected from each tree for botanical identification. The ends were painted to prevent drying out, and care was taken to preserve the bark intact. They were shipped in the log to Philip Gruner Bros. Lumber Co., St. Louis, where they were sawed into test sticks for the laboratory. For purposes of identification, each log was considered as divided into 4-ft. lengths called bolts which were consecutively lettered *a, b, c,* etc., beginning at the butt. Bolt *a* in each tree represented the first 4 feet from the stump, *b* the second 4 feet (the segment between 4 and 8 feet), *c* the third segment between 8 and 12 feet, and bolt *q* represented the segment betwen 64 and 68 feet (fig 1a).

Each bolt was outlined on the larger end (fig. 1b) from north to south through the pith and from east to west, in order that 4 series of specimens across the entire stem in the two directions could be identified. The lines were drawn at intervals of two inches, which allowed room for sawing and dressing the sticks. The individual specimens were then marked by tree number, bolt letter, compass direction, and distance from the pith. From the pith to the bark on the north and south sides there were two series of specimens numbered 1, 3, 5, 7, etc., and 2, 4, 6, 8, etc., respectively (fig. 1b). The same was true for the east and west sides beginning with the second specimen from the pith. Adjacent to each of these was a second series bearing sub-numbers. The latter series was available only in the larger trees. For example specimen 3eE3 from tree 3, bolt *e*, on the east side of the tree, with its center 3 inches from the pith, would be marked as shown in fig. 1c. The first figure in any specimen number or identification mark refers to the tree

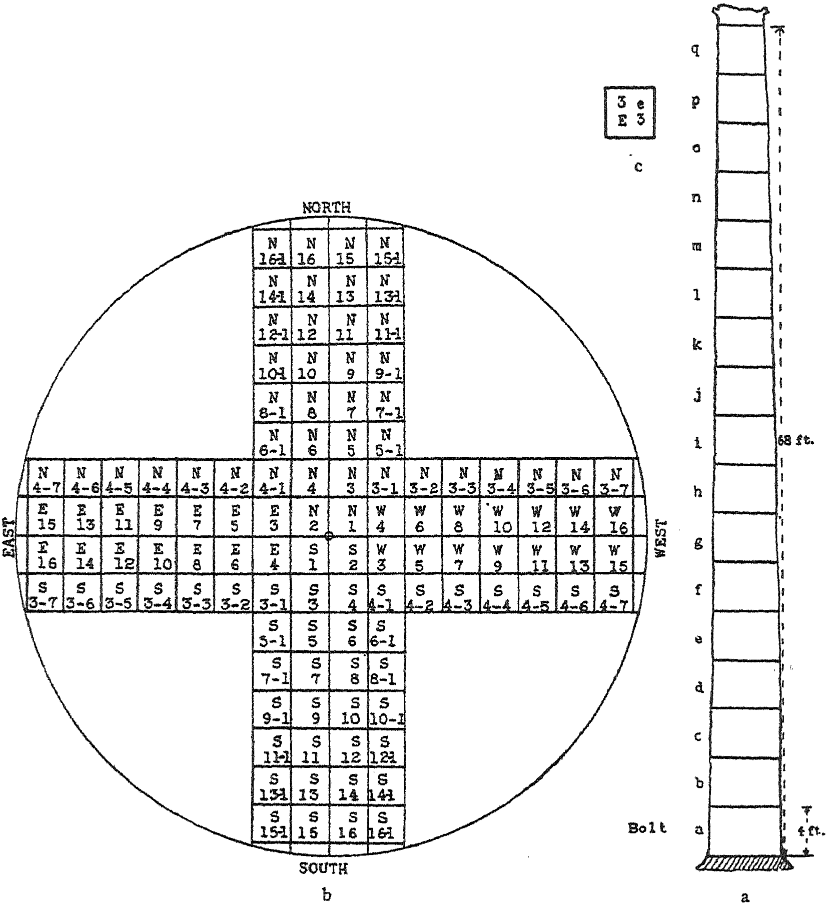
3 e
E 3
c
NORTH
N 16-1 N 16 N 15 N 15-1
N 14-1 N 14 N 13 N 13-1
N 12-1 N 12 N 11 N 11-1
N 10-1 N 10 N 9 N 9-1
N 8-1 N 8 N 7 N 7-1
N 6-1 N 6 N 5 N 5-1
N 4-7 N 4-6 N 4-5 N 4-4 N 4-3 N 4-2 N 4-1 N 4 N 3 N 3-1 N 3-2 N 3-3 N 3-4 N 3-5 N 3-6 N 3-7
E 15 E 13 E 11 E 9 E 7 E 5 E 3 N 2 N 1 W 4 W 6 W 8 W 10 W 12 W 14 W 16
E 16 E 14 E 12 E 10 E 8 E 6 E 4 S 1 S 2 W 3 W 5 W 7 W 9 W 11 W 13 W 15
S 3-7 S 3-6 S 3-5 S 3-4 S 3-3 S 3-2 S 3-1 S 3 S 4 S 4-1 S 4-2 S 4-3 S 4-4 S 4-5 S 4-6 S 4-7
S 5-1 S 5 S 6 S 6-1
S 7-1 S 7 S 8 S 8-1
S 9-1 S 9 S 10 S 10-1
S 11-1 S 11 S 12 S 12-1
S 13-1 S 13 S 14 S 14-1
S 15-1 S 15 S 16 S 16-1
EAST
WEST
SOUTH
b
q
p
o
n
m
l
k
j
i
h
g
f
e
d
c
b
Bolt a
68 ft.
4 ft.
a

Fig. 1. A diagrammatic sketch showing the method of selecting and marking test specimens. *a*, the trunk of the tree divided into bolts; *b*, the cross-section of a bolt, showing the method of labeling; *c*, a typical specimen with complete markings. The specimen indicated was from tree 3, bolt e, on the east side, and was the second specimen from the pith.

number, the first letter (which is always a small letter), to the bolt, the second letter (always a capital), to the compass direction, and the last figure or series of figures (as in 5bN3-3) gives the position along the radius or distance from the pith.

The method of marking specimens is in accord with the recommendations of the American Society for Testing Materials, except that the marking was done on the bottom or larger end of the bolt in order to save all specimens six inches or more in length in the outer sapwood.

The material tested green was surfaced at once and stored in wet sawdust in the laboratory during the period of testing. Moisture samples were taken from each test stick immediately on receipt at the laboratory in order to get a measure of the moisture distribution in the green tree. The material tested dry was allowed to season about three months in the rough, then surfaced and stored in the laboratory until tested. The material from trees 1 and 2 was kept in the laboratory for about a year before the tests were made.

## Physical Properties

### THE FIBER-SATURATION POINT

The fiber-saturation point of wood may be defined as the state in which the wood substance is saturated throughout without moisture existing as free water in the lumina of the cells or intercellular spaces. Theoretically, the physical properties of the wood fiber should not change with further additions of water since it would only displace the gases in the free spaces. Bearing in mind the fact that resins and oils present in the pine wood are not soluble in water, it can readily be seen that a perfect gradient of moisture, which is necessary in order to locate the exact point of saturation, is very difficult to obtain. The more common methods of measuring the fiber-saturation point are based upon either the change in volume of the specimen, the change in strength properties, or upon the change in specific conductance, all of which agree in general but vary over a wide range for any given specimen due to moisture gradients in the sample. The relationships of moisture-volume, moisture-strength, and moisture-conductance all show a sharp change in rate at the fiber-saturation point. The advantage of the electrical measurements is that very small specimens can be used, and thus a more perfect distribution of moisture can be obtained.

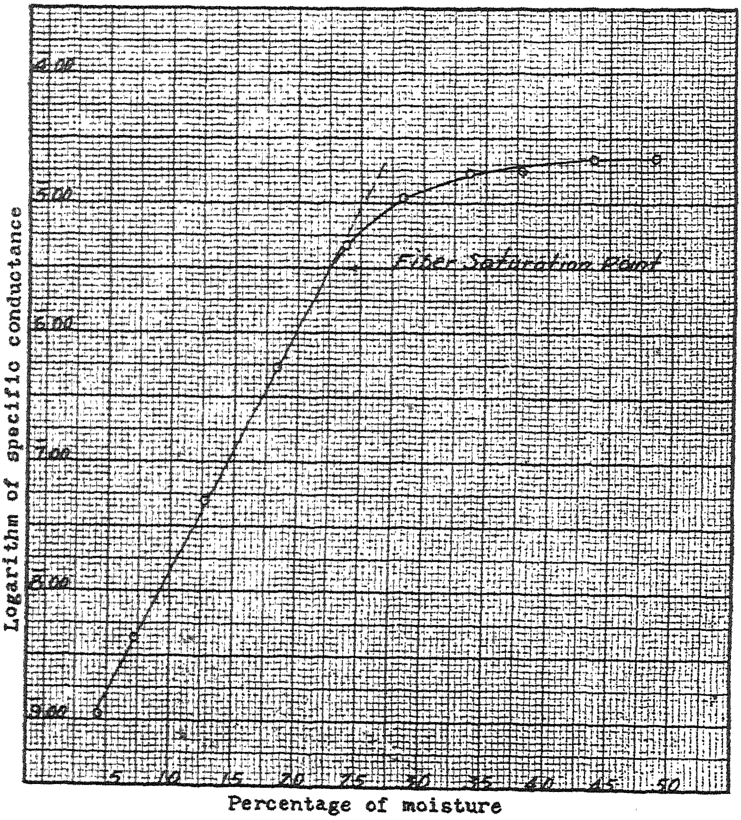

Fig. 2. The logarithm of the specific conductance plotted against the percentage of moisture. The sudden break in the curve indicates the fiber-saturation point, which was at 22.5 per cent moisture.

The fiber-saturation point reported here was obtained from electrical conductivity measurements made by the method introduced by Myer and Rees[3] and modified by Stamm ('29a). This method is known as the electro-conductivity method. The results obtained by it are based upon the assumption that the specific conductance of the wood varies directly in proportion to the increase in moisture from the oven-dry condition to the fiber-saturation point, where it ceases to increase in proportion to additional moisture. Therefore, when the logarithm of the specific conductance was plotted against the percentage of moisture, a straight line was obtained up to the fiber-saturation point, where it broke sharply to a curve (fig. 2).

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[3] Myer and Rees. 1926. Cited by Stamm ('29a).

Measurements made by this method are subject to considerable error, and accordingly only averages of a great number of individuals are of any value. The most outstanding variables were polarization and moisture gradients caused by the presence of resins. Stamm ('29a) stated that "the effects of possible polarization were found to be negligible because of the extremely low conductance measured." In these experiments this was not found to be true; polarization was strong in all cases, even with the lowest possible currents. Differences in the lengths of the specimens used also caused considerable variation in the conductance, even though they were kept in sealed bottles for twelve hours or more. Accordingly, the specimens used were kept as close to 1 mm. in length as possible.

The fiber-saturation point of the three species of southern yellow pine studied in these experiments was found to lie in the neighborhood of 22.5 per cent moisture. When the averages of smaller groups of data were plotted independently the fiber-saturation point varied somewhat, and the best interpretation that could be given to these results was 22.5 ± 1 per cent moisture. This is within the range reported by Tiemann ('06, '07) and Wilson, Carlson and Luxford ('30), based upon bending and compression strengths.

The difference between species was well within the range of the individual variations of any given species, but a sufficiently large number of individual measurements on the separate species might show a consistent difference. This number would necessarily be very great and on resin-free wood.

### MOISTURE CONTENT

The moisture content of the test specimens was determined from 1-in. sections cut between the bending and compression specimens, and from 2-in. samples cut from the compression specimens. These sections were weighed immediately after the test specimens were cut, dried to constant weight at 95–100° C., and reweighed. In very resinous specimens these determinations were subject to some error. Resinous materials tended to evaporate at temperatures around 100° C. and occasionally the liquid resin dripped from the specimens while in the oven.

Tests were made on material from four different conditions of moisture: material just as it came from the green log, material seasoned in an open-air shed, material cured in the relatively warm laboratory, and oven-dried material. Only the tests made on green material and that seasoned in the laboratory are reported here.

In trees 1 and 2 *(Pinus Taeda)*, tested in the lab.-dry condition, the material had been stored in the laboratory for about a year, so it was very dry and for the most part of a uniform moisture content. Tree 1 averaged 7.1 per cent moisture with a range from 6.0 to 8.8 per cent. Tree 2 averaged 7.3 per cent with a range from 5.5 to 11.1 per cent (table VI).

In the green material little variation was found in the moisture content of the heartwood in any one tree, regardless of position. There were only a few specimens in the heartwood of tree 4 that were in the range of the fiber-saturation point. (See strength tables VII and VIII for the moisture data.) The *average* moisture content of the entire section has no particular significance due to varying amounts of sapwood and the sharp differentiation of moisture in heart- and sapwood.

### ABSOLUTE DENSITY OF THE WOOD SUBSTANCE

The absolute density of pine wood fiber as reported here is the weight of a unit volume of the resin-free wood substance in relation to the same volume of water at 4° C. Measurements were made on sawdust by the pycnometer method at a constant temperature of 30° C. The sawdust was taken from various positions in the tree and from each of the different species. It was first dried and treated for some time in benzol, which was kept warm in an oven, to extract the resin and other soluble compounds. The benzol was then removed with alcohol and the sawdust dried to constant weight at about 80° C. Next, it was boiled for some time in water, and a vacuum of about 25 cm. was applied at intervals to remove the air. This was continued until the air was replaced by water and the bottle reached a constant weight at 30° C. A range of values from 1.5156 to 1.5273 was found, with an average of 1.52 obtained by dropping the last two decimal places. The absolute density of southern yellow pine wood substance is thus given as 1.52.

Stamm ('29b) reported the density of *Pinus Taeda* as 1.531 (pycnometer method) when he used water, and 1.466 with benzol. Dunlop ('14) reported a density of 1.6197 for *Pinus palustris* by using acid and of 1.5060 with water, but since all of his results varied considerably he suggested 1.54 as a mean to represent in a rough way wood substance from all species.

## PERCENTAGE OF RESIN

The percentage of benzol-soluble compounds designated as resins was determined by the loss of weight of oven-dried sawdust after soaking it for some days in benzol. The sawdust was taken from the compression and specific gravity specimens.

There was a certain relationship between the number of resin ducts and the percentage of resin, but no consistent correlation. The percentage of resin was greatest in the first 2 to 4 inches from the pith, often decreasing very sharply and then increasing again in the outer sapwood (tables VII and VIII). Resin was also abundant in and around injuries and knots, but it was often in localized areas where there was no sign of injury or knots and no increase in number or size of resin ducts. The percentages of resin reported here are in close agreement with the results given by Gomberg ('93), who made a more or less thorough study of the resin of *Pinus palustris* from Alabama.

## SPECIFIC GRAVITY

The specific gravity was determined from 6-in. samples cut from between the bending and compression specimens in trees 1–5 and from 2-in. samples cut from the compression specimens in trees 6 and 7. There was less variation in the density-strength relations in the latter two trees. In the green material the samples were weighed in air and in water, dried to constant weight and reweighed. The specific gravity was calculated from the green volume and the oven-dry weight. The seasoned specimens were weighed in air and in water as above, but the sap pieces were reweighed in air, after being wiped off with a cloth, in order to determine the change in weight due to absorption of water while submerged.

It was found that sapwood specimens absorbed from 3 to 10 per cent of water during the process of weighing. It can readily be seen that the specific gravity thus obtained was subject to a certain amount of error. This error was diminished by reweighing but it may still be sufficient to affect the density-strength relations.

The presence of resin increased the specific gravity considerably, and where the resin was in localized areas or pockets the change in density was very sudden with no corresponding change in strength. In the case of very resinous material, the specific gravity was more than 0.1 too high, and in extreme cases more than 0.2. Only the corrected values were used in the interpretations of strength and structure in this paper.

Since the specific gravity of a particular specimen increased with a decrease in moisture, due to shrinkage below the fiber-saturation point, only specimens of about the same moisture content should be compared. Since the fiber ceased to expand with additional moisture above the fiber-saturation point, specific gravity values for green wood were especially comparable where they were corrected for resin.

The specific gravity in trees 1, 2, 3, 5, 6, and 7 decreased at a more or less uniform rate towards the top of the tree, whereas in tree 4 it fluctuated from bolt to bolt, reaching a maximum in bolt *c*, decreasing considerably in bolt *d*, and again increasing through bolts *e* and *f*.

In trees 1, 2, and 7 the specific gravity increased from the pith to the bark, whereas in trees 3, 4, and 6 the increase extended over only the first 2 to 3 inches after which there was a decrease towards the periphery. This condition was due to the very slow growth of the latter trees. In tree 3, however, this relation changed. The first samples around the pith had the greatest density in the lower bolts, whereas the intermediate or outer specimens were the heaviest in bolt *h*. In tree 5 the specific gravity increased from the pith to a maximum in the outer part of the heartwood and decreased from this point towards the bark.

The maximum and minimum specific gravity for the bolt rarely occurred on the same side of the tree. In trees 1, 2, 3, and 4 the greatest density was usually found in the closer-ringed material, whereas in tree 5 it was found in the medium- to broad-ringed material. In the latter case, however, the narrow-ringed material was found on the outer portion of the tree, and it is indicated that in general the tracheid length and density reached a maximum at about the same time (between 40 and 100 years), which varied somewhat with the growth rate of the tree. The material from the first 30 to 40 rings and the outer sapwood of the older trees was lighter in all cases than the material laid down during the 40- to 100-year period. It is evident that the rate of growth and age of the tree are the controlling factors determining the position of greatest density in the cross-section of a given tree.

## Structural Properties

### RATE OF GROWTH

By observing the relative number of growth rings per inch it was found that the material represented in this study divided itself into three natural divisions: trees 1, 2, and 7 *(Pinus Taeda)* of very rapid growth, tree 5 *(Pinus Taeda)* and tree 3 *(Pinus echinata)* of medium growth, and trees 4 and 6 *(Pinus palustris)* of very slow growth (table I).

Trees 1, 2, and 7 grew more than three times as fast as trees 4 and 6 and twice as fast as tree 3. Therefore, the first test

## TABLE I

### FIELD NOTES FOR THE SEVEN TREES STUDIED

| | Tree 1<br>*P. Taeda* | Tree 2<br>*P. Taeda* | Tree 5<br>*P. Taeda* | Tree 7<br>*P. Taeda* | Tree 3<br>*P. echinata* | Tree 4<br>*P. palustris* | Tree 6<br>*P. palustris* |
|---|---|---|---|---|---|---|---|
| Where grown | Near Tylertown, Miss. | Near Tylertown, Miss. | About 8 mi. west of Sandy Hook, Miss., near La. border | In Tylertown, Miss. | Near Tylertown, Miss. | Near Tylertown, Miss. | Near Tylertown, Miss. |
| Approximate elevation | 225 ft. | 250 ft. | 225 ft. | — | 265 ft. | 300 ft. | — |
| Soil conditions | Moderately dry clay loam | Set clay loam | Moist sandy clay | Sandy clay top soil, red clay sub-soil | Dry sandy clay | Dry sandy clay | Sandy clay top soil, red clay sub-soil |
| Exposure | West slope | Flat | Flat | Gentle south slope | Steep northwest slope | Steep southwest slope | Gentle north slope |
| Stand of timber | Dense second growth in old field | Moderately dense original swamp growth | Dense original hard wood with scattered pine trees | Open second growth hard and soft wood | Moderately dense original growth recently cut over, leaving open stand | Dense original growth recently cut over | Open second growth recently cut over |
| Height of tree | 93 ft. | 85 ft. | 135 ft. | 98 ft. | 75 ft. | 75 ft. | 82 ft. |
| Diameter under bark at butt | 18 in. (7 in. from ground) | 18½ in. (30 in. from ground) | 43 in. | 19½ in. | 17¾ in. (10 in. from ground) | 16½ in. (10 in. from ground) | 17½ in. |
| Approximate age | 50 yrs. | 50 yrs. | 160 yrs. | 60 yrs. | 100 yrs. | 160 yrs. | 160 yrs. |
| Rate of growth | Rapid | Rapid | Medium to rapid except for very slow growing outer 4 or 5 in. | Rapid | Moderately slow | Very slow | Very slow |
| Date of cutting | Oct. 4, 1930 | Oct. 4, 1930 | Oct. 2, 1931 | Feb. 1, 1933 | Oct. 4, 1930 | Oct. 4, 1930 | Dec. 6, 1932 |

specimens near the pith of trees 1 and 2 represented only three to four years' growth, those of tree 5, six to fourteen, while there were more rings in some of the first specimens of tree 4 and especially tree 6 than there were in the entire cross-sections of trees 1, 2, and 7 (pl. 9). Trees 4 and 6 had from 10 to 44 rings per inch. This would give from 15 to 66 growth rings for each 1½ x 1½-in. specimen. Since the growth was not uniformly slow throughout the entire cross-section, there were few test specimens that contained more than 50 growth rings. The number of rings per inch is given in tables VII and VIII.

Trees 1, 2, 5, and 7 *(Pinus Taeda)* were more or less symmetrical in outline with the pith near the center, thus giving approximately the same number of test specimens on each side. Accordingly, there was little difference in the number of rings per inch at a given distance from the pith either on the opposite sides or at different levels.

Tree 3 *(Pinus echinata)* was slightly crooked and asymmetrical. The pith was nearer the bark on the south and west sides at the butt, whereas it was near the center of the log in bolt *h* at about 30 feet from the ground. The rings on the narrow side were necessarily closer, and since the pith was not straight it was impossible to cut an equal number of the specimens on each of the four sides. The growth was somewhat more rapid through the second and sometimes the third specimen in the lower bolts, and averaged about 8 rings per inch, but out near the bark, especially on the south and west sides, the growth decreased rapidly, giving about 15 to 20 rings per inch.

Trees 4 and 6 *(Pinus palustris)* were also crooked, with the pith off center. The *h* bolt in tree 4 and the *a* bolt in tree 6 were asymmetrical. Trees 4 and 6 had only two or three medium-width rings around the pith, after which the growth was extremely slow in the first 2 to 3 inches, except for a very few rings which occurred in scattered groups. The growth was somewhat more rapid in the outer part of the heartwood and in the sapwood towards the top of the tree.

These trees were characterized by periods of alternately slow and more rapid growth. While the entire tree would be considered to have slow growth, the rate changed at intervals from about 20 rings per inch to more than 40 rings and back to 15 or 20 without following any particular pattern. Moreover, the width of ring varied greatly on opposite sides of the tree. Therefore, pieces taken at a given distance from the pith on opposite sides were not always matched specimens; one specimen may have been formed as much as forty years after the other. The broader rings often contained a certain amount of compression wood.

### SUMMER WOOD

The percentage of summer wood was estimated macroscopically when the specimens were measured for testing. In the samples in which the resin ducts and shape of fiber were studied, the summer wood was measured under the microscope. Since in general the estimated values were found to be either too high, as in the specimens containing more than 50 per cent summer wood, or too low, only the percentage of summer wood obtained by microscopic measurements are reported here.

The first 2 to 5 rings of the tree usually contained very little summer wood. There was no sharp demarcation between early and late wood, and it was not uncommon for the first ring to be entirely without thick-walled cells such as were found in the summer wood farther from the pith. One was compelled to set an arbitrary limit on the spring and summer wood in such cases, since the cells were progressively smaller and thicker-walled towards the outer part of the ring. In some trees poor differentiation occasionally occurred in annual rings far from the pith. This was particularly noticeable in trees 1 and 2 *(Pinus Taeda)* where a large percentage of compression wood was found.

In the young rapid-growth trees 1, 2, and 7 *(Pinus Taeda)*, the percentage of summer wood increased from the pith to the periphery whereas in the older and slower-growing trees 3 *(Pinus echinata)*, 4 and 6 *(Pinus palustris)*, and 5 *(Pinus Taeda)* it reached a maximum some distance from the bark and then decreased. (Mohr and Roth, '97, found this to be true of all old trees.) In the close-ringed trees a maximum of summer wood was often reached within the first 2 to 3 inches of the pith, with little variation over the rest of the cross-section.

The percentage of summer wood varied a great deal with height in the tree. Trees 1 and 2, representing vigorous-growth *Pinus Taeda,* averaged nearly twice as much summer wood at the butt as at a point 30 feet higher. In the slower-growing trees 3 *(Pinus echinata)* and 6 *(Pinus palustris),* the decrease was not so rapid, and in tree 4 *(Pinus palustris),* the percentage of summer wood decreased progressively but not uniformly from butt to top.

The ''average'' percentage of summer wood may be misleading in rapid-growth trees, since in a given cross-section considerable areas near the pith had as little as 15 per cent summer wood whereas only a few inches farther out there was often 60 per cent or more. Furthermore, the density of summer wood varied in the individual trees and particularly in trees of different species, as will be discussed in detail later.

### SIZE AND DISTRIBUTION OF THE RESIN DUCTS

Resin ducts are canal-like intercellular spaces surrounded by parenchyma cells. The cells immediately around them, known as epithelial cells, were thin-walled and were more or less equilateral. The succeeding cells radiating from the resin ducts had increasingly thicker walls and became elongated until they blended into the tracheids. It was not uncommon for septate tracheids to occur in this transition zone.

Table II shows the size and distribution of the resin ducts both as to height and to distance from the pith in the tree. The samples for study were taken from the specimens used for the compression tests.

There was no attempt to determine the lengths of the longitudinal resin ducts which were distributed throughout the xylem. They were more abundant immediately around the pith, especially in the first 5-10 annual rings. The first ring often contained as many as 500 resin ducts, while farther out towards the periphery of the stem they were most numerous in the regions of transition from spring to summer wood and

## TABLE II

THE SIZE AND DISTRIBUTION OF THE RESIN DUCTS AND THE PERCENTAGE OF AREA OCCUPIED BY THEM. THE PERCENTAGE OF SUMMER WOOD IS GIVEN IN TABLES VII AND VIII

| Specimen | Number of resin ducts per sq. cm. | | Mean diameter in mm. | Percentage of area of cross-section |
|---|---|---|---|---|
| | spring wood | summer wood | | |
| Tree 1—*Pinus Taeda* (loblolly pine) | | | | |
| 1aN2 | 33 | 64 | 0.20 | 1.32 |
| 1aN4 | 6 | 79 | 0.22 | 1.61 |
| 1aN6 | 1 | 58 | 0.23 | 1.68 |
| 1aN7 | 2 | 48 | | 1.62 |
| 1aN8 | 2 | 54 | 0.24 | 1.89 |
| 1dN2 | 43 | 52 | 0.19 | 1.25 |
| 1dN4 | 2 | 70 | 0.21 | 1.10 |
| 1dN6 | 0 | 55 | 0.23 | 1.05 |
| 1hN2 | 34 | 86 | 0.20 | 1.26 |
| 1hN4 | 41 | 63 | 0.22 | 1.82 |
| 1hN6 | 6 | 72 | 0.23 | 1.24 |
| Tree 2—*Pinus Taeda* (loblolly pine) | | | | |
| 2aN2 | 54 | 71 | 0.20 | 1.86 |
| 2aN4 | 34 | 70 | 0.22 | 2.08 |
| 2aN5 | 25 | 50 | | 1.65 |
| 2aN6 | 15 | 42 | 0.23 | 1.32 |
| 2aN8 | 8 | 47 | 0.24 | 1.47 |
| 2dN1 | 54 | 85 | | 2.05 |
| 2dN2 | 38 | 57 | 0.21 | 1.51 |
| 2dN4 | 26 | 51 | 0.23 | 1.58 |
| 2dN5 | 28 | 45 | | 1.61 |
| 2dN6 | 23 | 39 | 0.24 | 1.40 |
| 2dN8 | 17 | 43 | 0.25 | 1.47 |
| 2hN1 | 69 | 85 | | 2.50 |
| 2hN2 | 34 | 58 | 0.21 | 1.34 |
| 2hN3 | 35 | 72 | | 1.85 |
| 2hN4 | 38 | 60 | 0.23 | 1.85 |
| 2hN5 | 36 | 58 | | 1.95 |
| 2hN6 | 35 | 43 | 0.24 | 1.71 |
| 2hN8 | 27 | 49 | 0.24 | 1.70 |
| Tree 5—*Pinus Taeda* (loblolly pine) | | | | |
| 5bN1 | 45 | 55 | 0.19 | 1.53 |
| 5bN3 | 53 | 21 | 0.20 | 1.13 |
| 5bN5 | 53 | 20 | 0.21 | 1.13 |
| 5bN7 | 50 | 37 | 0.23 | 1.74 |
| 5bN9 | 46 | 43 | 0.23 | 1.83 |
| 5bN11 | 40 | 29 | 0.23 | 1.37 |
| 5bN13 | 8 | 48 | 0.22 | 1.23 |
| 5bN15 | 17 | 54 | 0.21 | 1.27 |

TABLE II (Continued)

| Specimen | Number of resin ducts per sq. cm. | | Mean diameter in mm. | Percentage of area of cross-section |
|---|---|---|---|---|
| | spring wood | summer wood | | |
| Tree 5 (Continued) | | | | |
| 5iN1 | 40 | 72 | 0.19 | 1.31 |
| 5iN3 | 29 | 42 | 0.21 | 1.14 |
| 5iN5 | 15 | 52 | 0.22 | 1.17 |
| 5iN7 | 29 | 28 | 0.23 | 1.19 |
| 5iN9 | 20 | 43 | 0.23 | 1.22 |
| 5iN11 | 9 | 39 | 0.23 | 0.92 |
| 5iN13 | 17 | 95 | 0.22 | 1.67 |
| 5qN1 | 40 | 52 | 0.19 | 1.19 |
| 5qN3 | 33 | 37 | 0.20 | 1.18 |
| 5qN5 | 27 | 46 | 0.21 | 1.12 |
| 5qN7 | 23 | 57 | 0.23 | 1.42 |
| 5qN9 | 9 | 75 | 0.23 | 1.25 |
| 5qN11 | 17 | 106 | 0.22 | 1.61 |
| Tree 7—*Pinus Taeda* (loblolly pine) | | | | |
| 7aN1 | 17 | 76 | 0.20 | 1.12 |
| 7aN3 | 21 | 50 | 0.22 | 1.20 |
| 7aN5 | 21 | 34 | 0.25 | 1.29 |
| 7aN7 | 13 | 38 | 0.25 | 1.25 |
| 7gN1 | 21 | 44 | 0.21 | 1.03 |
| 7gN3 | 20 | 41 | 0.22 | 1.07 |
| 7gN5 | 11 | 48 | 0.23 | 1.12 |
| 7gS7 | 16 | 52 | 0.23 | 1.31 |
| 7mN1 | 23 | 35 | 0.21 | 0.92 |
| 7mN3 | 9 | 58 | 0.23 | 1.18 |
| 7mN5 | 11 | 51 | 0.24 | 1.37 |
| 7mS7 | 16 | 50 | 0.23 | 1.29 |
| Tree 3—*Pinus echinata* (shortleaf pine) | | | | |
| 3aN1 | 18 | 30 | 0.19 | 0.69 |
| 3aN2 | 38 | 48 | | 1.24 |
| 3aN3 | 23 | 19 | 0.20 | 0.66 |
| 3aN4 | 24 | 22 | | 0.72 |
| 3aN5 | 33 | 26 | 0.20 | 0.91 |
| 3aN6 | 15 | 28 | | 0.73 |
| 3aN7 | 30 | 28 | 0.21 | 1.00 |
| 3aN8 | 19 | 22 | | 0.71 |
| 3aN9 | 30 | 26 | 0.21 | 1.00 |
| 3aN10 | 30 | 26 | | 0.97 |
| 3dN1 | 24 | 43 | 0.19 | 0.89 |
| 3dN3 | 23 | 22 | 0.20 | 0.71 |
| 3dN5 | 29 | 30 | 0.20 | 0.92 |
| 3dN7 | 19 | 21 | 0.21 | 0.69 |

TABLE II (Continued)

| Specimen | Number of resin ducts per sq. cm. | | Mean diameter in mm. | Percentage of area of cross-section |
|---|---|---|---|---|
| | spring wood | summer wood | | |
| Tree 3 (Continued) | | | | |
| 3hN1 | 22 | 32 | 0.19 | 0.70 |
| 3hN2 | 22 | 49 | | 0.89 |
| 3hN3 | 15 | 20 | 0.20 | 0.52 |
| 3hN5 | 20 | 15 | 0.20 | 0.57 |
| Tree 4—*Pinus palustris* (longleaf pine) | | | | |
| 4aN2 | 19 | 67 | 0.19 | 1.07 |
| 4aN4 | 27 | 45 | 0.20 | 1.10 |
| 4aN6 | 27 | 45 | 0.21 | 1.21 |
| 4aN8 | 37 | 39 | 0.22 | 1.34 |
| 4cN1 | 27 | 67 | 0.20 | 1.08 |
| 4cN2 | 35 | 69 | | 1.22 |
| 4cN3 | 27 | 63 | 0.21 | 1.27 |
| 4cN5 | 36 | 34 | 0.22 | 1.17 |
| 4hN1 | 33 | 23 | 0.19 | 1.15 |
| 4hN2 | 25 | 44 | | 0.85 |
| 4hN3 | 28 | 49 | 0.22 | 1.06 |
| 4hN4 | 26 | 47 | | 0.96 |
| Tree 6—*Pinus palustris* (longleaf pine) | | | | |
| 6aN1 | 18 | 78 | 0.20 | 1.45 |
| 6aN3 | 14 | 31 | 0.23 | 0.90 |
| 6aN5 | 29 | 50 | 0.25 | 1.82 |
| 6aS7 | 22 | 41 | 0.25 | 1.41 |
| 6eN1 | 43 | 92 | 0.20 | 1.69 |
| 6eN3 | 27 | 62 | 0.22 | 1.51 |
| 6eN5 | 20 | 56 | 0.23 | 1.32 |
| 6iN1 | 38 | 53 | 0.20 | 1.32 |
| 6iN3 | 24 | 45 | 0.22 | 1.07 |
| 6iN5 | 33 | 47 | 0.24 | 1.65 |

in the summer wood, with very few in the first part of the spring wood. This was particularly noticeable in the broad-ringed material (pl. 10, fig. 1). Resin ducts were often aggregated in false rings and occasionally formed a definite band near the middle of the spring wood rings. In narrow-ringed material the resin ducts were scattered promiscuously throughout the annual ring, but, with the exception of certain specimens in *Pinus echinata,* they were more numerous in the summer-wood portion.

The mean diameter of the resin ducts increased from the pith towards the periphery of the stem, reaching a maximum near the outer sap-wood, but occasionally it decreased slightly in the last-formed rings in the older trees. The greater number of resin ducts in the first and last rings was quite marked in tree 5.

The percentage of cross-sectional area taken up by resin ducts was slightly greater in the rapid-growth *Pinus Taeda* than in the other species. In *Pinus Taeda* the area taken up by them increased in the summer-wood portion of the ring towards the periphery of the stem and decreased markedly in the spring wood in the same direction, whereas in *Pinus palustris* and in *Pinus echinata* there was no consistent change. In *Pinus echinata* the resin ducts were smaller and fewer in number than in the other species. On the whole there was less than 1 per cent of the cross-sectional area taken up by them. In the summer wood of *Pinus palustris* and *Pinus Taeda,* however, it was not uncommon for more than 2 per cent, and for small areas as much as 3 per cent, of the area to be occupied by resin ducts.

In general, the mean diameter of the resin ducts was slightly greater in the spring wood than in the summer wood, although the diameters in the tangential direction were frequently greater in the summer wood, where the resin ducts were often aggregated in rows of from 2 to 5 (pl. 10, fig. 2). This was particularly true of *Pinus Taeda,* where the aggregations were occasionally about 1 mm. in width. Such groups also occurred in the spring wood but they were much less common. In no instance was there any evidence of injury in the vicinity of these groups of resin ducts.

There was no consistent relationship between the number of resin ducts and the height of the tree. However, as a whole the mean diameters of the resin ducts, and thus the area taken up by them, were greatest in the lower bolts. They decreased slightly through the middle portion of the tree and usually increased again near the top. This condition, however, was often reversed in individual specimens from the outer portion of the tree.

Areas of parenchyma cells occurred, other than those around the resin ducts, which areas contained secretory or resin cells. The greater number of them were thick-walled. These areas of parenchyma cells were more common in the spring wood and occurred in all three species.

### SIZE AND DISTRIBUTION OF THE WOOD RAYS

The significance of the wood rays in relation to the structure and strength of wood attracted the attention of Nördlinger ('60), and in 1881 he published his findings on the number of rays per mm. for a number of hard woods and noted the numerous small rays in the conifers.

Essner ('82) studied the distribution and height of the rays in various species of conifers. He found little or no difference in the number of rays on the narrow side of trees caused by unequal growth rate, but did observe that certain specimens of *Cupressus sempervirens* of symmetrical growth had 83 rays per mm. on one side as compared with 62 on the opposite side. The height of the rays increased from the pith to the bark.

Jaccard ('15) studied the rays at the various levels in the tree and in the branches of *Sequoia* and *Picea*. In the main stem or trunk the rays decreased in number from a maximum at the base to a minimum within the lower part of the trunk and again increased towards the top of the tree. They were more numerous but smaller in the branches where the greatest number was found in the areas of compression wood on the lower side. He observed that as the rays decreased in number the tracheids increased in size. Myer ('22) reported the ray volumes of a large number of American woods and pointed out that the hard woods had a much greater ray volume than the conifers, an average of 17.04 and 7.08 per cent, respectively. The ray volumes for the southern pines were 7.63 per cent for *Pinus Taeda,* 8.05 per cent for *Pinus echinata,* and 8.30 per cent for *Pinus palustris.* In summarizing his results, Myer ('30) stated that the ray volume of white pine, hemlock, and sugar maple was greatest at the top of the merchantable log and second greatest at the stump level, while a reduction was found at the 16-ft. level. His observations as recorded in the paper, however, show the maximum at the stump level. If the latter is the correct conclusion, it agrees with other work. There was no consistent relationship between the ray volume and the different sites from which the trees were cut. The ray height in the sugar maple was least at the stump level but its width was greatest at this point. Myer's ('30) observations on the effects of the site do not agree entirely with those of Hartig ('01) on the oak. The latter found a greater ray volume in the plants grown in the open and an increase in ray volume if shaded plants were suddenly given full illumination. Forsaith ('20) found a reduction of rays in certain alpine forms, and Shope ('27) found that the size of the ray cells, as well as other cells, increased in the aspen at higher elevations. Harlow ('27) was unable to find any consistent variations in the ray volume of plants from different sites. He observed, however, that it was greater at the base of the tree. There was a great variation in the size, type, and distribution of rays in the different species of hard woods, depending upon their ages, according to Zache ('86), Hartig ('94), and Eames ('10).

It is evident that there is not sufficient data to draw any reliable conclusions as to the size and distribution of wood rays due to environmental conditions or their effects on strength, but it is universally agreed that the ray volume of conifers is greatest in the butt of the tree and least in the main trunk at a height of 20 to 40 feet.

In this investigation the wood rays of southern pine were found to be largely of the linear (uniseriate) and fusiform (multiseriate) types. The latter contained solitary lateral resin ducts. Occasional biseriate rays were observed, but these were rare and of little significance in this study. The area of the rays was determined by taking two-thirds of the area of a circumscribed parallelogram based upon the mean height and breadth of the rays in a given specimen.

The study was made on tangential sections mounted in Canada balsam, and the measurements were made by means of a micrometer eyepiece. The number per mm. was determined by taking the average from 100 to 400 sq. mm. This was made possible by using a cover glass on which fine lines were etched at a distance of about 0.8 mm. The number of rays between the lines could be accurately counted for the entire area of a large section, since the lines were sufficiently transparent to allow the counting of rays beneath them.

*Fusiform Rays.*—The width (lateral diameter), the height (longitudinal diameter), the distribution of the fusiform rays, and the percentage of area occupied by them is given in table III. The width of these rays varied from about 0.05 mm. to about 0.08 mm. They were smaller near the pith and reached a maximum near the periphery of the stem. There was little difference in the breadth of the rays in the different species. The height of the fusiform rays, in most specimens, tended to decrease from the butt of the tree towards the top, reaching a minimum through the middle portion of the tree. In tree 7 *(Pinus Taeda)*, however, it increased slightly from the base to the top.

The fusiform rays were more or less constant in number at the different heights in the tree, but they decreased very markedly from the pith towards the periphery of the stem at all levels studied. However, since the number per unit area often varied more than 100 per cent in local areas, it was necessary to study a number of sq. cm. in order to get a reliable average. In 1aN6 (table III) there was an average of 83 fusiform rays per sq. cm., and in certain sections taken at this point there were more than 100 per sq. cm.

Fusiform rays were more abundant in *Pinus Taeda* than in either *Pinus palustris* or *Pinus echinata*, but there was no pronounced difference in the height of these rays in either species. There was no indication of a fixed pattern or sequence of occurrence in any of the species. They were scattered throughout, but occurred occasionally in groups.

*Linear Rays.*—The linear rays were very numerous in the first growth ring, where there were from 70 to 120 minute rays per sq. mm. immediately adjacent to the pith. They were

## TABLE III

### THE SIZE AND DISTRIBUTION OF THE FUSIFORM RAYS

| Specimen | Approximate number of rings from the pith | Number of rays per sq. cm.* | Mean width in mm. | Mean height in mm. | Percentage of area occupied by fusiform rays |
|---|---|---|---|---|---|
| Tree 1—*Pinus Taeda* (loblolly pine) | | | | | |
| 1aN2 | 3 | 71 | 0.061 | 0.343 | 0.99 |
| 1aN4 | 16 | 50 | 0.063 | 0.436 | 1.02 |
| 1aN6 | 34 | 83 | 0.068 | 0.428 | 1.61 |
| 1aN8 | 45 | 38 | 0.075 | 0.521 | 0.99 |
| Ave. | | 60 | 0.066 | 0.432 | 1.15 |
| 1dN2 | 3 | 76 | 0.060 | 0.350 | 1.25 |
| 1dN4 | 13 | 50 | 0.059 | 0.422 | 0.84 |
| 1dN6 | 30 | 47 | 0.062 | 0.422 | 0.82 |
| 1dN8 | 40 | 45 | 0.073 | 0.504 | 1.10 |
| Ave. | | 55 | 0.063 | 0.425 | 1.00 |
| 1hN2 | 3 | 43 | 0.062 | 0.359 | 0.64 |
| 1hN4 | 11 | 38 | 0.067 | 0.398 | 0.72 |
| 1hN6 | 25 | 38 | 0.070 | 0.500 | 0.89 |
| Ave. | | 40 | 0.066 | 0.419 | 0.75 |
| Tree 2—*Pinus Taeda* (loblolly pine) | | | | | |
| 2aN2 | 3 | 57 | 0.060 | 0.328 | 0.75 |
| 2aN4 | 10 | 38 | 0.063 | 0.462 | 0.73 |
| 2aN6 | 20 | 30 | 0.072 | 0.537 | 0.78 |
| 2aN8 | 35 | 31 | 0.066 | 0.514 | 0.70 |
| Ave. | | 39 | 0.065 | 0.460 | 0.74 |
| 2dN2 | 3 | 56 | 0.078 | 0.393 | 0.77 |
| 2dN4 | 10 | 35 | 0.055 | 0.410 | 0.54 |
| 2dN6 | 19 | 39 | 0.058 | 0.400 | 0.60 |
| 2dN8 | 30 | 31 | 0.066 | 0.500 | 0.67 |
| Ave. | | 40 | 0.062 | 0.427 | 0.65 |
| 2hN2 | 3 | 59 | 0.055 | 0.250 | 0.76 |
| 2hN4 | 10 | 38 | 0.067 | 0.379 | 0.65 |
| 2hN6 | 17 | 35 | 0.063 | 0.470 | 0.73 |
| 2hN8 | 28 | 30 | 0.067 | 0.484 | 0.65 |
| Ave. | | 41 | 0.063 | 0.396 | 0.70 |

* Note that the number of fusiform rays is given in sq. cm.

TABLE III (Continued)

| Specimen | Approximate number of rings from the pith | Number of rays per sq. cm.* | Mean width in mm. | Mean height in mm. | Percentage of area occupied by fusiform rays |
|---|---|---|---|---|---|
| Tree 5—*Pinus Taeda* (loblolly pine) | | | | | |
| 5bN1 | 10 | 54 | 0.063 | 0.328 | 0.75 |
| 5bN7 | 46 | 37 | 0.076 | 0.487 | 0.91 |
| 5bN1-5 | 125 | 26 | 0.075 | 0.744 | 0.97 |
| Ave. | | 39 | 0.071 | 0.519 | 0.87 |
| 5iN1 | 6 | 67 | 0.065 | 0.312 | 0.91 |
| 5iN7 | 40 | 34 | 0.077 | 0.434 | 0.74 |
| 5iN13 | 105 | 28 | 0.069 | 0.577 | 0.74 |
| Ave. | | 43 | 0.070 | 0.441 | 0.79 |
| 5qN1 | 4 | 58 | 0.057 | 0.288 | 0.63 |
| 5qN5 | 27 | 39 | 0.068 | 0.488 | 0.86 |
| 5qN11 | 88 | 34 | 0.073 | 0.522 | 0.86 |
| Ave. | | 44 | 0.066 | 0.433 | 0.78 |
| Tree 7—*Pinus Taeda* (loblolly pine) | | | | | |
| 7aN1 | 5 | 56 | 0.059 | 0.330 | 0.73 |
| 7aN3 | 15 | 43 | 0.065 | 0.368 | 0.69 |
| 7aN5 | 26 | 37 | 0.084 | 0.373 | 0.77 |
| 7aN7 | 40 | 35 | 0.085 | 0.402 | 0.79 |
| 7aN9 | 50 | 34 | 0.067 | 0.414 | 0.63 |
| Ave. | | 41 | 0.072 | 0.377 | 0.72 |
| 7gN1 | 4 | 46 | 0.056 | 0.367 | 0.63 |
| 7gN3 | 13 | 42 | 0.061 | 0.372 | 0.63 |
| 7gN5 | 25 | 38 | 0.063 | 0.371 | 0.59 |
| 7gN7 | 39 | 38 | 0.058 | 0.410 | 0.60 |
| Ave. | | 41 | 0.059 | 0.380 | 0.61 |
| 7mN1 | 4 | 62 | 0.064 | 0.321 | 0.85 |
| 7mN3 | 13 | 50 | 0.066 | 0.423 | 0.93 |
| 7mN5 | 26 | 43 | 0.067 | 0.459 | 0.88 |
| 7mN7 | 40 | 45 | 0.066 | 0.485 | 0.89 |
| Ave. | | 50 | 0.066 | 0.422 | 0.89 |

* Note that the number of fusiform rays is given in sq. cm.

TABLE III (Continued)

| Specimen | Approximate number of rings from the pith | Number of rays per sq. cm.* | Mean width in mm. | Mean height in mm. | Percentage of area occupied by fusiform rays |
|---|---|---|---|---|---|
| Tree 3—*Pinus echinata* (shortleaf pine) | | | | | |
| 3aN1 | 12 | 32 | 0.057 | 0.474 | 0.57 |
| 3aN3 | 35 | 43 | 0.059 | 0.485 | 0.82 |
| 3aN5 | 59 | 33 | 0.061 | 0.497 | 0.67 |
| 3aN7 | 84 | 32 | 0.065 | 0.532 | 0.74 |
| 3aN9 | 108 | 28 | 0.068 | 0.550 | 0.70 |
| Ave. | | 36 | 0.062 | 0.507 | 0.70 |
| 3dN1 | 16 | 30 | 0.057 | 0.400 | 0.46 |
| 3dN3 | 44 | 28 | 0.059 | 0.430 | 0.47 |
| 3dN5 | 70 | 28 | 0.063 | 0.482 | 0.57 |
| 3dN7 | 98 | 27 | 0.068 | 0.504 | 0.61 |
| Ave. | | 28 | 0.062 | 0.454 | 0.53 |
| 3hN1 | 12 | 44 | 0.057 | 0.370 | 0.63 |
| 3hN3 | 35 | 28 | 0.063 | 0.389 | 0.46 |
| 3hN5 | 61 | 27 | 0.068 | 0.410 | 0.50 |
| Ave. | | 33 | 0.062 | 0.389 | 0.53 |
| Tree 4—*Pinus palustris* (longleaf pine) | | | | | |
| 4aN2 | 36 | 43 | 0.054 | 0.335 | 0.52 |
| 4aN6 | 122 | 31 | 0.063 | 0.474 | 0.67 |
| 4aN8 | 150 | 31 | 0.071 | 0.614 | 0.90 |
| Ave. | | 36 | 0.062 | 0.474 | 0.66 |
| 4dN1 | 40 | 39 | 0.061 | 0.441 | 0.71 |
| 4dN3 | 103 | 33 | 0.068 | 0.497 | 0.74 |
| 4dN5 | 145 | 28 | 0.073 | 0.543 | 0.69 |
| Ave. | | 33 | 0.067 | 0.493 | 0.71 |
| 4hN1 | 21 | 36 | 0.068 | 0.368 | 0.50 |
| 4hN3 | 67 | 30 | 0.071 | 0.428 | 0.61 |
| 4hN5 | 110 | 30 | 0.075 | 0.489 | 0.73 |
| Ave. | | 32 | 0.071 | 0.425 | 0.65 |

* Note that the number of fusiform rays is given in sq. cm.

TABLE III (Continued)

| Specimen | Approximate number of rings from the pith | Number of rays per sq. cm.* | Mean width in mm. | Mean height in mm. | Percentage of area occupied by fusiform rays |
|---|---|---|---|---|---|
| Tree 6—*Pinus palustris* (longleaf pine) | | | | | |
| 6aN1 | 43 | 31 | 0.056 | 0.372 | 0.35 |
| 6aN3 | 67 | 26 | 0.066 | 0.389 | 0.48 |
| 6aN5 | 106 | 27 | 0.070 | 0.480 | 0.62 |
| 6aN7 | 142 | 28 | 0.072 | 0.480 | 0.65 |
| Ave. | | 28 | 0.066 | 0.430 | 0.52 |
| 6eN1 | 25 | 28 | 0.053 | 0.348 | 0.34 |
| 6eN3 | 75 | 33 | 0.057 | 0.427 | 0.52 |
| 6eN5 | 115 | 25 | 0.069 | 0.406 | 0.46 |
| Ave. | | 29 | 0.060 | 0.394 | 0.44 |
| 6iN1 | 28 | 30 | 0.059 | 0.342 | 0.42 |
| 6iN3 | 72 | 28 | 0.071 | 0.415 | 0.57 |
| 6iN5 | 112 | 28 | 0.066 | 0.474 | 0.61 |
| Ave. | | 29 | 0.065 | 0.410 | 0.53 |

* Note that the number of fusiform rays is given in sq. cm.

naturally very small at this point, being only about 0.08 mm. or less in height. As the stem increased in diameter the rays were separated more and more, new ones originating with the additional tiers of tracheids. Since the number of rays did not increase so rapidly as the diameter of the stem, there was only about one-fourth to one-sixth as many rays per sq. mm. in the outer portion as near the pith.

The decrease in number of rays was not uniform in all specimens nor all portions of a given specimen. At certain areas in the tree marked only by a sudden change in growth rate, there was a temporary increase in number of rays which was followed by the usual rate of decline.

Table IV gives the number of linear rays per sq. mm., their mean heights and breadths, and the approximate area taken up by them in the different portions of the tree as indicated. Since the size of the rays often increased more rapidly than the number decreased, in many bolts the area occupied by them was greatest in the outer portion of the tree. This was true of all three species studied.

The breadth of the rays increased centrifugally only slightly, from about 0.022 to 0.028 mm. The height increased more or less rapidly, attaining an average of more than 0.2 mm. in certain trees, although individual rays were occasionally 1 mm. or more in height in *Pinus Taeda.*

The number of rays was practically constant for a given area at different heights in the tree, except in the butt where there were a few more. Their breadth was also reasonably uniform throughout the tree, but the height decreased slightly from the stump level through the middle portion of the trunk, with a second maximum in the region of the crown. For this reason the area taken up by the rays was greatest at the base and least at about the 30- to 40-ft. level.

The linear rays, like the fusiform, were more numerous at a given distance from the pith and slightly larger in the specimens of *Pinus Taeda* than in either *Pinus palustris* or *Pinus echinata,* the latter of which had fewer and smaller rays. If, however, the age of the tree were taken into consideration, *Pinus echinata* and *Pinus palustris* had a greater number of rays than did *Pinus Taeda* due to the narrow rings near the pith.

Tables VII and VIII show that *Pinus echinata* had a lower percentage of area occupied by resin ducts and wood rays than *Pinus palustris,* and that *Pinus Taeda* had a greater percentage than the other two. It was unfortunate that there was only one tree of *Pinus echinata* available for study, since there were certain variations shown in the different trees of the other two species. Furthermore, tree 3 grew on a north slope where it was probably shaded a good part of the time, which, according to Hartig's ('01) observations, would account for the smaller number of rays.

There were only slight variations in number or size of linear rays on opposite sides of a given tree, but areas containing a large amount of compression wood had somewhat broader rays and a greater number of both fusiform and linear rays, which increased the ray volume somewhat.

## TABLE IV

### THE SIZE AND DISTRIBUTION OF THE LINEAR RAYS

| Specimen | Appoximate number of rings from the pith | Number of rays per sq. mm. | Mean width in mm. | Mean height in mm. | Percentage of area occupied by linear rays |
|---|---|---|---|---|---|
| Tree 1—*Pinus Taeda* (loblolly pine) | | | | | |
| 1aN1 | 3 | 32 | 0.023 | 0.161 | 7.93 |
| 1aN3 | 16 | 29 | 0.024 | 0.168 | 7.80 |
| 1aN5 | 34 | 28 | 0.025 | 0.182 | 7.80 |
| 1aN7 | 45 | 28 | 0.026 | 0.191 | 9.26 |
| 1dN1 | 3 | 30 | 0.022 | 0.172 | 8.10 |
| 1dN3 | 13 | 25 | 0.023 | 0.174 | 7.10 |
| 1dN5 | 30 | 24 | 0.025 | 0.186 | 7.50 |
| 1dN7 | 40 | 22 | 0.026 | 0.190 | 7.50 |
| 1hN1 | 3 | 26 | 0.023 | 0.180 | 7.35 |
| 1hN3 | 11 | 24 | 0.026 | 0.182 | 7.13 |
| 1hN5 | 25 | 22 | 0.026 | 0.190 | 7.14 |
| Tree 2—*Pinus Taeda* (loblolly pine) | | | | | |
| 2aN1 | 3 | 30 | 0.024 | 0.167 | 8.00 |
| 2aN3 | 10 | 27 | 0.026 | 0.170 | 7.93 |
| 2aN5 | 20 | 26 | 0.026 | 0.204 | 9.20 |
| 2aN7 | 35 | 25 | 0.027 | 0.194 | 8.72 |
| 2dN1 | 3 | 29 | 0.024 | 0.159 | 7.25 |
| 2dN3 | 10 | 27 | 0.025 | 0.165 | 7.27 |
| 2dN5 | 19 | 26 | 0.026 | 0.184 | 8.05 |
| 2dN7 | 30 | 25 | 0.027 | 0.198 | 8.92 |
| 2hN1 | 3 | 30 | 0.025 | 0.161 | 7.60 |
| 2hN3 | 10 | 27 | 0.026 | 0.164 | 7.23 |
| 2hN5 | 17 | 25 | 0.026 | 0.169 | 7.12 |
| 2hN7 | 28 | 24 | 0.027 | 0.207 | 9.10 |
| Tree 5—*Pinus Taeda* (loblolly pine) | | | | | |
| 5bN1 | 10 | 28 | 0.022 | 0.160 | 6.15 |
| 5bN7 | 46 | 24 | 0.025 | 0.186 | 7.60 |
| 5bN15 | 125 | 20 | 0.025 | 0.244 | 8.75 |
| 5iN1 | 6 | 26 | 0.022 | 0.150 | 5.43 |
| 5iN7 | 40 | 23 | 0.024 | 0.170 | 7.02 |
| 5iN13 | 105 | 20 | 0.026 | 0.194 | 7.00 |
| 5qN1 | 4 | 25 | 0.023 | 0.160 | 5.55 |
| 5qN5 | 27 | 23 | 0.026 | 0.200 | 9.74 |
| 5qN11 | 88 | 22 | 0.025 | 0.198 | 7.20 |

TABLE IV (Continued)

| Specimen | Appoximate number of rings from the pith | Number of rays per sq. mm. | Mean width in mm. | Mean height in mm. | Percentage of area occupied by linear rays |
|---|---|---|---|---|---|
| Tree 7—*Pinus Taeda* (loblolly pine) | | | | | |
| 7aN1 | 5 | 31 | 0.023 | 0.155 | 7.25 |
| 7aN3 | 15 | 30 | 0.023 | 0.168 | 8.37 |
| 7aN5 | 26 | 29 | 0.024 | 0.171 | 8.17 |
| 7aN7 | 40 | 25 | 0.024 | 0.173 | 7.02 |
| 7aN9 | 56 | 26 | 0.024 | 0.162 | 6.90 |
| 7gN1 | 4 | 30 | 0.023 | 0.141 | 6.46 |
| 7gN3 | 13 | 27 | 0.023 | 0.158 | 6.45 |
| 7gN5 | 25 | 26 | 0.024 | 0.153 | 6.54 |
| 7gN7 | 39 | 28 | 0.024 | 0.127 | 5.74 |
| 7mN1 | 4 | 30 | 0.023 | 0.149 | 6.65 |
| 7mN3 | 13 | 28 | 0.024 | 0.151 | 6.67 |
| 7mN5 | 26 | 27 | 0.024 | 0.150 | 6.55 |
| 7mN7 | 40 | 29 | 0.024 | 0.151 | 7.15 |
| Tree 3—*Pinus echinata* (shortleaf pine) | | | | | |
| 3aN1 | 12 | 25 | 0.023 | 0.145 | 5.30 |
| 3aN3 | 35 | 24 | 0.023 | 0.148 | 5.44 |
| 3aN5 | 59 | 23 | 0.023 | 0.153 | 5.37 |
| 3aN7 | 84 | 22 | 0.024 | 0.160 | 5.63 |
| 3aN9 | 108 | 21 | 0.025 | 0.166 | 5.80 |
| 3dN1 | 16 | 25 | 0.022 | 0.140 | 5.14 |
| 3dN3 | 44 | 24 | 0.023 | 0.145 | 5.35 |
| 3dN5 | 70 | 23 | 0.024 | 0.157 | 5.76 |
| 3dN7 | 98 | 22 | 0.024 | 0.160 | 5.62 |
| 3hN1 | 12 | 26 | 0.022 | 0.143 | 5.45 |
| 3hN3 | 35 | 24 | 0.023 | 0.149 | 5.50 |
| 3hN5 | 61 | 21 | 0.024 | 0.158 | 5.31 |
| Tree 4—*Pinus palustris* (longleaf pine) | | | | | |
| 4aN2 | 36 | 24 | 0.023 | 0.151 | 5.94 |
| 4aN6 | 122 | 24 | 0.024 | 0.159 | 6.50 |
| 4aN8 | 150 | 23 | 0.026 | 0.167 | 7.05 |
| 4dN1 | 40 | 25 | 0.024 | 0.152 | 5.95 |
| 4dN3 | 103 | 24 | 0.024 | 0.154 | 6.04 |
| 4dN5 | 145 | 23 | 0.026 | 0.158 | 6.11 |
| 4hN1 | 21 | 24 | 0.023 | 0.148 | 5.30 |
| 4hN3 | 67 | 24 | 0.024 | 0.151 | 5.47 |
| 4hN5 | 110 | 23 | 0.024 | 0.152 | 5.60 |

TABLE IV (Continued)

| Specimen | Approximate number of rings from the pith | Number of rays per sq. mm. | Mean width in mm. | Mean height in mm. | Percentage of area occupied by linear rays |
|---|---|---|---|---|---|
| Tree 6—*Pinus palustris* (longleaf pine) | | | | | |
| 6aN1 | 43 | 28 | 0.022 | 0.141 | 5.79 |
| 6aN3 | 67 | 25 | 0.023 | 0.154 | 5.90 |
| 6aN5 | 106 | 23 | 0.024 | 0.208 | 7.64 |
| 6aN7 | 142 | 23 | 0.025 | 0.195 | 7.46 |
| 6eN1 | 25 | 27 | 0.021 | 0.145 | 5.45 |
| 6eN3 | 75 | 24 | 0.022 | 0.145 | 5.18 |
| 6eN5 | 115 | 23 | 0.024 | 0.168 | 6.50 |
| 6iN1 | 28 | 25 | 0.021 | 0.143 | 5.61 |
| 6iN3 | 72 | 24 | 0.023 | 0.159 | 5.76 |
| 6iN5 | 112 | 23 | 0.024 | 0.202 | 7.80 |

## TRACHEID DIMENSIONS

The length of the tracheids in coniferous wood varies with the age of the tree at the time the cells are formed. Sanio ('72) found that in *Pinus sylvestris* the tracheids increased in length from the first ring to a maximum in the 45th ring, after which they remained constant. This led him to believe that the size of the cell had a fixed relationship to the age of the tree, but this has been proved untrue. Mell ('10) observed that the wood fibers were longest, for any given annual ring, in rapid-growth trees. Bailey and Shepard ('15) noted that in certain species of conifers the length of the tracheids increased from the inner portion of the secondary xylem up to a certain age, after which it fluctuated. No constant length of tracheids was found. In addition, Gerry ('15) found that the fiber length increased from the butt towards the crown for about two-thirds of the height of the tree. The longest fibers in a given ring were in the first spring-wood cells and the shortest in the last summer-wood cells. Gerry ('16), contrary to Mell, was not able to find any correlation between fiber length and rate of growth in Douglas fir, but noted a rapid increase in all dimensions of the fiber in the first twenty years of growth. Lee and Smith ('16), on the other hand, found that in Douglas fir the longest fibers in a given ring were in the summer wood. Further study on the fiber length of different species was made by Bailey and Tupper ('18), Kribs ('28), and Gerry ('29). MacMillan ('25) found that there was a greater percentage of short fiber in red spruce grown under suppressed conditions than in that grown in free, which agrees with the findings of Mell.

In this study, the tracheids were prepared for measuring by first macerating them (Jeffrey method) and then teasing them apart on the stage of a compound microscope. Measurements were made by means of a micrometer eye-piece. Each figure shown in tables VII and VIII is the average of 200–500 tracheids.

The tracheids were very short in the first ring around the pith, with an average length of 1.5 mm. or less. Their length increased rapidly through the first 5 to 10 rings and more gradually for the remainder of the growth of the tree or at least until the tree reached the age of 100 years or more. No maximum length was determined in this material.

In a given tree the length of the tracheids was dependent upon the number of years of growth and not upon the distance from the pith; therefore, in broad-ringed material they were shorter at a given distance from the pith than in the narrow-ringed material. This was very outstanding in the different trees used in this study. In trees 1, 2, and 7, and somewhat in tree 5 (all *Pinus Taeda*), the rings were broad near the pith and for some distance out, whereas in tree 3 *(Pinus echinata)* and particularly in trees 4 and 6 *(Pinus palustris)* the rings were very narrow. Consequently, the average length of the tracheids in the first test specimen near the pith in trees 3, 4, and 6 was as great as it was in the second or third specimen from the pith in trees 1, 2, 5, and 7. The tracheids representing approximately the same year's growth were slightly longer in the rapid-growth *Pinus Taeda* than in the other species.

At the successively higher levels in the tree, the tracheids increased in length more rapidly from the pith to the bark. The result was that the average length for the cross-section tended to increase towards the top of the tree. The tracheids in a given ring increased in length towards the top, especially for the first few feet from the butt.

Groups of short tracheids were often found throughout the cross-section of the tree, particularly in the spring wood which usually contained the longest ones. Where the short tracheids occurred, there was frequently a difference of as much as 100 per cent in their lengths. Therefore, the average length of the summer wood tracheids was usually greater than that of the spring wood. Crooked tracheids and areas of compression wood usually had a greater variation in length than material containing straight tracheids with concentric laminae.

In trees 1, 2, and 7 *(Pinus Taeda)*, which were of about the same age and growth rate, the tracheid length was approximately the same for a given position. The average length of the tracheids for the various levels represented by the specimens is given in tables vii and viii. The slight differences found on the opposite sides of the tree were insignificant. In tree 5 *(Pinus Taeda)* the somewhat narrower rings were correlated with a more rapid increase in length of tracheids from pith to periphery, especially in bolts *i* and *q*. In this tree the average length was 5 mm. or more in the outer specimens except in bolt *b* which was from the butt log.

Tree 3 *(Pinus echinata)* had approximately the same length tracheids for a given growth ring as trees of *Pinus Taeda,* but the rings were much narrower; therefore, the average length in the first test specimens near the pith was approximately 4 mm. It is evident that these test specimens contained a large percentage of tracheids which were 4.5 mm. or more in length, since those of the first rings were very short.

Trees 4 and 6 *(Pinus palustris)* had somewhat shorter tracheids for a given ring than the *Pinus Taeda* trees studied, but the average length for a given specimen was greater due to the very slow growth.

The mean diameter of the tracheids increased with the increase in length. The diameter of the spring-wood tracheids was from one-third to one-half greater than those of the summer wood. The maximum diameters observed for the spring wood tracheids of *Pinus Taeda* were about 0.06 mm. in the first 2 or 3 rings to about 0.085 mm. in the outer part of the trees. For corresponding positions in the tree, *Pinus echinata* showed an increase from about 0.06 to 0.072 mm., and *Pinus palustris* from 0.05 to 0.07 mm. In the summer wood of *Pinus Taeda* the maximum diameters increased from about 0.04 mm. in the first rings to about 0.052 mm. in the outer part of the trees, in *Pinus echinata* from about 0.04 to 0.049 mm., and in *Pinus palustris* from about 0.032 to 0.044 mm. The average diameter was somewhat lower in all cases and increased in about the same ratio, but since the tracheids tapered from near the middle towards either end, it was very difficult to determine the average diameters. To give a true value it would be necessary to isolate the cells and measure them at a given point but the large numbers necessary for a significant figure made this impractical. A cursory study showed that the average diameter of the tracheids increased from the base of the tree towards the top, at least for the first few feet. Since the wood rays and resin ducts vary within small limits, the thickness of the cell walls was best reflected in the specific gravity. Therefore, it was considered unnecessary to make a statistical study of them.

## TRACHEID IRREGULARITIES

The length of the tracheids, as stated above, had a definite relation to their age and position in the tree, while the differences in general contour of the cells and the thickness of the cell walls were more or less correlated with the spring and summer wood. On the other hand, the tracheids varied greatly in degree of straightness with little relation to position in the tree. In general, they were straighter in the upper and outer portions, but this relation did not hold for all trees or for all positions in a given tree. Areas of crooked tracheids occurred in any portion of the tree, and were common in the butt bolts and the first rings around the pith. Crooked tracheids occurred characteristically in compression wood but also around knots, adventitious buds, leaf traces, injuries, and in the otherwise clear wood.

Crooked tracheids can usually be detected by the irregularity of the rupture when small slivers are split from the specimen, by a rough or splintery surface in dressed material (especially in material of high density), and by a waviness in the annual rings or a curly grain. Crooked tracheids must not be confused with spiral-grain, which also may give a rough surface in dressed material, although they were found to be associated with it in tree 5. Cross- or spiral-grained material gives a rough surface if dressed against the grain and a smooth surface if dressed with it, whereas material containing unusually crooked tracheids gives an uneven surface when dressed in either direction.

Straight uniform tracheids, except for slight curvatures at the wood rays (pl. 10, fig. 3), with tapering sharp-pointed ends were found in all the trees studied, but they were accompanied by areas of crooked tracheids. Trees 1, 2, and 7 contained a large percentage of tracheids which were straight except for recurved or crooked ends. This was especially true of the very rapid-growth material near the pith and the slow-growth material in the sapwood of the older trees. In tree 5 and in certain areas of all the trees, the tracheids were wavy throughout (pl. 10, fig. 4). The V-shaped markings shown in pl. 9, fig. 3 (5bN12) were made up of these crooked tracheids. In general, where this irregularity was not due to a knot or other disturbance as stated above, the curve of one tier was opposite that of the adjacent tier so that the tracheids crossed each other (pl. 10, fig. 5). The intercellular spaces caused by the crossing of the cells prevented compactness of form and interrupted the gluing layer.

Other elements that might be classed as inferior in strength properties are compression wood, and the occurrence of parenchyma cells around the resin ducts (pl. 10, fig. 6) and in limited areas which appeared to be callus tissue. Compression wood will be discussed in detail in the next section.

## THE STRUCTURE OF THE CELL WALL

The physical properties and chemical constituents of the cell walls of plants in relation to microscopic structure have attracted the attention of botanists for many years. Nägeli ('64) observed a definite concentric lamination of broad light bands alternating with narrow dark ones in the cell walls of flax fibers. He advanced the theory of alternate layers of cell wall material each containing different amounts of water. By the use of swelling reagents he observed striations on the surfaces of the fibers which he designated as fibrils. He noted further that the fibrils in adjacent laminae ran in opposite directions, each lying in a spiral around the cell. Anderson ('27) expressed the belief that the laminae were not alternate layers of water-rich and water-poor cellulose, but that they represented the boundary lines of the layers of cellulose. He later ('28a) modified his conclusions, stating that the alternate layers were of different chemical constituents, and ('28b) he observed that in the epidermis of *Clivia nobilis* the cell wall was made up of alternating layers of cellulose and pectin. Anderson ('27) and Ritter ('28) were able to separate the laminae from each other.

The middle lamella of lignified tissues was believed to be composed largely of lignin by Ritter ('25), Harlow ('27), Candlin and Schryver ('28), Harlow and Wise ('28), and Scarth, Gibbs, and Spier ('30), none of whom denied the possibility of pectin being present. The recent work of Kerr and Bailey ('33) states that the middle lamella is a combination of lignin and pectin. The secondary thickening may be composed either of cellulose and lignin (Scarth, Gibbs, and Spier, '30) or of cellulose alone. It is likely, however, that the secondary wall contains a certain amount of pectin. This is indicated by the recent work of Farr and Eckerson ('33) on the cotton fiber and of Kerr and Bailey ('33) on woody cells.

The amplification of the micellar theory of Nägeli by the use of X-rays as reviewed by Clark ('30) and Thiessen ('32) has demonstrated the dimensions and orientation of the micells, which have been found to lie at various angles to the axes of the fibers. Cotton fibers which have the greatest tensile strength are those with the fibrils parallel with the axes (Farr and Clark, '32).

Spierer constructed a special lens used as an oil-immersion objective (Seifriz, '31). Seifriz ('31) and Thiessen ('32), using the Spierer lens, reported diffraction patterns of macromicells (aggregates of true micells similar in shape to the latter) in plant cell walls. Thiessen reported the same phenomenon in partially decayed wood and coal.

The writer has been unable to substantiate this interpretation by the use of the Spierer lens at magnifications up to 2700 diameters,[4] but the laminae have been clearly outlined, thus showing in detail the gross structure of the cell wall. The cross-sections[5] of ordinary cells showed the laminae to be in the form of concentric rings or cylinders (pl. 11, fig. 1). It will be observed that the middle lamella was not differentiated from the secondary thickening. The same structure was readily demonstrated with direct illumination (pl. 11, fig. 2). Longitudinal sections of similar cells showed the laminae to be arranged uniformly and parallel with each other (pl. 11, fig. 3). The lumina of the cells appeared as dark bands, and in no instance was there any trace of macro-micells in the diffraction patterns.

"Compression wood," so-called because it was thought to be confined to the under side of limbs and leaning stems of Gymnosperms (originally described as *Rothholz* by German investigators because of its reddish color), has been described as tracheids that have rounded corners and that are characterized by a thick, heavily lignified, and spirally striated inner layer of the secondary wall.

There have been a number of theories advanced to explain the development of this type of wood, which have been reviewed by Kienholz ('30). The fact that these cells were found in abundance on the compression side of the tree led investigators to believe that they were caused by the compression stresses existing on the cells during growth, but recent findings indicate that they may be caused by gravity or by injury to the growing cells.

Both the spring and summer wood of a growth ring, or only a portion of either, may be made up of compression wood. Thin layers of it occurred in the summer-wood portion of narrow rings, and isolated cells were found in both the spring and summer wood, thus completely hidden from the unaided eye (pl. 11, fig. 4). It could be readily recognized in stained sections under the microscope, however, by the difference in color caused by differential staining, the contour of the cells, and particularly by the structure of the secondary thickening of the cell walls. The white spots to be seen in the photograph cited above were due to checks which were clearly visible in the longitudinal section (pl. 11, fig. 5) and in the cross-section at higher magnification (pl. 11, fig. 6). It will also be observed that the checks lie at an angle to the longitudinal axes of the tracheids, forming a spiral around the cells (pl. 11, fig. 5).

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[4] In addition to the Spierer lens, which is an oil-immersion objective (90 x), a 30 x ocular was used.

[5] The sections were made both with and without desilicification by the use of hydrofluoric acid. The same structure was revealed in either case. This was also true of the sections of compression wood.

In general, the line of demarcation between the two types of cells was very sharp where the compression wood was first laid down, but it blended gradually into the normal cells as it disappeared. All gradations of the two types of cells were found in the outer limits of the layer. The compression wood cells often had greater radial diameters and larger lumina than the adjacent summer-wood cells on either side (pl. 11, fig. 4), but this was not always the case since compression wood cells were often similar in shape and size to the ordinary cells, differing only in the structure of the secondary thickening (pl. 12, fig. 3). More highly developed compression wood cells, however, were rounded, leaving interstitial spaces (pl. 11, fig. 6).

When cross-sections of these cells were observed under high magnification (pl. 12, fig. 1), it was found that instead of concentric rings (lamellae) there were radial bands running from the region of the middle lamella to the lumen of the cell as described by Hartig ('96). These bands showed even more clearly under the Spierer lens (pl. 12, figs. 2 and 3) and their outlines and direction may also be observed with the cardeoid dark-field condenser (pl. 12, figs. 4 and 5). Although usually radial they were occasionally at an angle to the radius and were often irregular and crooked as can be seen in the illustrations. All gradations from the concentric laminae of the middle lamella to the typically radial bands shown in pl. 12, fig. 1, were found. The region of the middle lamella had the same concentric arrangement as the cells illustrated in pl. 11, fig. 1, thus making a distinct demarcation between the middle lamella and the secondary thickening (pl. 11, fig. 6). These radial bands in the secondary wall of the compression wood cells appeared then to be the lamellae so distorted and displaced that they were no longer concentric cylinders but discontinuous radial bands. At frequent intervals they separated, forming checks or cracks in the cell wall, which usually extended only through the secondary thickening. It can readily be seen that on seasoning stresses would be set up not only between the compression wood and ordinary cells but also between the middle lamellae and secondary thickenings of the same cell.

When longitudinal sections of similar compression wood cells were observed under the Spierer lens, the alternating light and dark lines were found to be running in a spiral around the fiber, similar to the checks, except in the region of the middle lamella (pl. 12, fig. 6). The same phenomenon was observed when these cells were examined under the dark field (pl. 12, fig. 7). Here, as in pl. 11, fig. 5, the spiral lines between the checks were visible, showing the identical structure which is illustrated more clearly by the Spierer lens (pl. 12, fig. 6). These sections were cut tangentially through the secondary thickening of the cell wall, and the lines are the edges of the radial laminae. Here again the middle lamella is differentiated from the secondary thickening. In the former the laminae lie parallel to the axis of the tracheids, whereas in the latter they lie in a spiral. Then, in addition to being radial, the laminae of the compression wood cells are spiral plates which may be likened to the threads in a fine screw.

In the literature the terms "compression wood" and "*Rothholz*" are confined to the reddish cells found on the under side of leaning trees and the lower side of branches, characterized by their high density and by interstitial spaces. Koehler ('30) stated, however, that "In loblolly pine and redwood relatively high longitudinal shrinkage has been found in second-growth trees with very wide annual rings containing summer wood which is not so dark and hard as in normal wood.

Such wood resembles 'compression wood' in some respects but differs from it in extending entirely around the tree trunk and in some microscopic features." The microscopic features were not described by Koehler.

In the present study this type of wood was abundant in the more rapid-growth *Pinus Taeda* and was found in limited quantities in the other two species. It occurred on opposite sides of the same cross-section, in isolated areas, and as individual cells. On examination it was found to have the radial laminae spirally arranged in the cell wall which were characteristic of the typical compression wood or *Rothholz* cells. Therefore, it is evident that the old terms must be modified or replaced so that they will include all cells of a similar structure regardless of color or position.

Accordingly, the writer is suggesting a new term: *torquimural* (from the Latin *torqueo,* to twist or distort, and *murus,* wall). This term is based upon the structure of the cells and not upon their occurrence, which makes it applicable to any cell having this type of structure. Torquimural cells (as found in the southern yellow pines) may be defined as *tracheids with or without interstitial spaces, moderately to very dense, the secondary wall of the individual cell differentiated from the primary wall by its radial bands or laminae which lie in a spiral around the cell.* This term is not necessarily intended to replace the older terms but to describe a definite type of cell which is characteristic of compression wood or *Rothholz* but not limited to it.

In order to differentiate the torquimural tracheids from those having concentric laminae it becomes necessary to define the latter with a corresponding term based upon the structure of the cell wall. The term *concentrimural*[6] (concentric, having a common center, and the Latin *murus,* wall) is suggested. Concentrimural tracheids may be defined as *cells usually without interstitial spaces, thin- or thick-walled, the secondary thickening and the middle lamella of which are made up of layers or laminae in the form of concentric cylinders.* These terms will be used in the ensuing discussions where the two types of cells are compared or contrasted.

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[6] The writer wishes to acknowledge the assistance of Mr. J. A. Moore, a graduate student in plant anatomy at Washington University, in selecting these terms.

## The Nature of the Failure and the Distribution of Strength in the Tree

### COMPRESSION FAILURES

The nature of the failure of a small specimen of clear southern yellow pine wood subjected to pressure parallel to the grain depended upon (1) the density of the material, (2) the type of cells present (torquimural or concentrimural tracheids), and (3) the moisture content. In general, the plane of the major failure was in the direction of a tangent to the annual rings (pl. 13, fig. 1), although occasionally it occurred across the rings. Thil ('00) attributed the failure along the rings rather than across them to the supposition that the wood rays were arranged in spiral rows around the tree and that the plane of the spiral was weak. Fulton ('12) and Forsaith ('21) observed that the initial cause of all failure lay in the medullary rays. The displacement of fibers around the medullary rays, the reduction in diameter at this point, and the poor cohesion between the fibers and the rays caused a point of weakness. Robinson ('21) did not attribute the initial failure in spruce to the effects of the rays, but in ash and to some extent in pitch pine the rays were effective in causing failure. Jaccard ('13) denied the existence of spiral rows of rays as reported by Thil and expressed the belief that the rays were more resistant to pressure than the fibers, that the rupture came within the ray and not between it and the fibers. He did, however, recognize the curvature of the fibers around the rays, but stated that the failure was without constant relation to the rays. Bienfait ('26) suggested that the rays added strength in the radial direction and that the failure in the tangential direction was possibly due to this stiffening effect.

Tiemann ('06), from his studies of seasoned red spruce and chestnut, suggested as a general rule that "all species of wood, which when dry show the first indication of failure under compression by a crinkling of the cell walls without bending of the fibers, would be rigid, brittle, difficult to bend without breaking, and would increase rapidly in strength with dryness, whereas species which show a tendency for the fibers to buckle without the crinkling of the cell walls would exhibit the opposite qualities.''

It is evident that Tiemann's observations were limited because the two types of failure may occur within the same growth ring and perhaps in the same cell at different degrees of dryness. Spring wood of rapid-growth material (which had large lumina and very thin walls) and brash wood (with an unusually high percentage of lignin or whose internal structure was unusual, such as torquimural cells) often crinkled or folded up, whereas concentrimural cells with thick walls usually buckled, unless the moisture content was very low. The secondary thickening of the thin-walled spring wood cell often broke loose from the middle lamella and folded into the lumen of the cell (pl. 13, fig. 2).

In specimens of green southern yellow pine under compression parallel to the grain, numerous wrinkles or offsets indicating failure were observed throughout the specimen. If the compression was continued one or more definite zones of failure developed, offsetting the specimen in one direction or forming a wedge split (pl. 13, fig. 1*b*). After the failure localized, most of the deformations over the remainder of the surface disappeared. Within this zone of failure the cells buckled, separating from each other or remaining in groups. These groups usually consisted of the tiers of fibers. In separating, the cell walls ruptured at the interface of the secondary thickening and the middle lamella, leaving the latter attached to one of the cells. In adjacent tiers of cells, the middle lamella often pulled away from the cell walls of one tier and remained attached to the other (pl. 13, fig. 2). This condition would be expected if the lignin of the middle lamella was somewhat stiffer and more brash than the cellulose walls (Dadswell and Hawley, '29).

The zone of major failure (plane of buckled cells) varied in size with the material tested. In tough green wood it often extended more than an inch along the specimen, and when the loading was continued after failure a large portion of the specimen was macerated or shredded. In general the entire mass of cells buckled in one direction (pl. 13, fig. 1*c*), but when longitudinal sections of this region of failure were examined under the microscope it was found that individual cells at various points buckled away from the larger wood rays, the cells on either side buckling in opposite directions (pl. 13, figs. 3 and 4). The natural curvature in the tracheids at the point where they pass the larger wood rays, particularly the fusiform rays, and the reduction in diameter were sufficient to cause a point of weakness. The rays running in the radial direction cause a line of cells on either side of each ray to be curved in one direction. There were from 25 to 100 fusiform rays per sq. cm. and from 2000 to 3000 linear rays per sq. cm. in the pines studied here; therefore it is the opinion of the writer that the curvature of the tracheids was the controlling factor in the direction of the failure. This was further substantiated by the fact that in a number of the specimens failing *across the rings* the tracheids were found to be crooked and the greatest curvature was in the radial direction. So far as the southern pines reported here are concerned, the rays were effective in the position and direction of the initial failure. However, there was no definite arrangement of the rays observed as assumed by Thil.

When the individual buckled cells were examined by means of the Spierer lens, it was found that the inner wall (in relation to the curve) had folded or wrinkled, whereas the outer wall was drawn tight (pl. 13, fig. 5). In the torquimural cells the walls gave way entirely (pl. 13, fig. 6) or folded up by a shredding of the spiral laminae.

The "slip planes" in the individual cells observed by Robinson ('21) and Bienfait ('26) were, in the opinion of the writer, due either to the folding of the cell walls in the region of the pits as described by Tiemann ('06) or to an artifact brought about by the rupture of the laminae which exposed the amorphous lignin and pectin and caused differential staining. Similar slip planes may also be observed in torquimural cells where the laminae separate, forming checks.

Tracheids were often observed to buckle into the resin ducts and thus become more completely separated from each other. In conclusion, it may be considered that an excess of large rays and resin ducts would reduce the strength per unit weight, but this effect was often overshadowed by crooked and otherwise inferior fibers.

## STRENGTH AND STRUCTURE

The strength tests reported in this paper were made in the civil engineering laboratory at Washington University, with the assistance of Mr. Charles O. Quade and Mr. Chester Abbey[7] and under the direction of Prof. A. W. Brust, assistant professor of civil engineering.

These tests consisted of static compression parallel to the grain made on specimens 1½ x 1½ x 6 inches (specimens having a nominal length 4 times the least dimension). Since the object was primarily to determine the causes of variations in strength of material having a given density and percentage of summer wood and the distribution of strength in the tree, it was more desirable to use smaller specimens than those of a size specified by the American Society for Testing Materials (pieces 2 inches square). By using the smaller specimens it was possible to divide the cross-sections of the trees more nearly into their natural zones: inner heartwood containing short tracheids and numerous small rays, intermediate and outer heartwood containing long tracheids and larger rays, and outer sapwood. This emphasized the great differences in strength caused by differences in density and fiber characteristics in these various zones.

The compression tests were made on a 3-screw Riehle 150,000-lb. universal type testing machine at a cross head speed of 0.018 in. per minute.

Tables v (green material) and vi (seasoned material) show by bolts the number of tests, the average specific gravity, percentage of summer wood, rings per inch, and compression strength of the 7 trees used in this study. The average percentage of moisture was omitted in table v because it was above the fiber-saturation point and had no significance, but it was included in table VI, which represents the seasoned material. The averages given represent all the tests made on the bolts used in the microscopic studies except a few individual tests from other bolts which showed unusual strength or weakness per unit weight. The corrected specific gravity[8] and measured

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[7] American Creosoting Co. Fellows in the department of civil engineering, Washington University.

TABLE V

RESULTS OF COMPRESSION TESTS AVERAGED BY BOLTS AND BY TREES—GREEN. THE AVERAGE STRENGTH IS BASED ON THE AREA REPRESENTED BY THE TESTS MADE AT VARIOUS DISTANCES FROM THE PITH

| Tree and bolt No. | Species | Number of tests | Original specific gravity | Corrected specific gravity | Estimated percentage of summer wood | Measured percentage of summer wood | Rings per inch | Maximum stress #/sq.in. |
|---|---|---|---|---|---|---|---|---|
| 5–b | *Pinus Taeda* | 53 | 0.549 | 0.521 (22)* | 49 | 57 | 7.8 | 3570 |
| 5–i | (loblolly pine) | 49 | 0.459 | 0.452 (30)* | 29 | 38 | 9.4 | 3328 |
| 5–q |  | 41 | 0.426 | 0.409 (25)* | 24 | 28 | 8.8 | 2594 |
|  | Ave. |  | 0.478 | 0.460 | 34 | 41 | 8.6 | 3164 |
| 7–a | *Pinus Taeda* | 15 | 0.491 | 0.485 | 48 | 50 | 5.7 | 3540 |
| 7–g | (loblolly pine) | 12 | 0.452 | 0.446 | 35 | 44 | 5.1 | 3450 |
| 7–m |  | 11 | 0.436 | 0.428 | 25 | 36 | 5.8 | 3360 |
|  | Ave. |  | 0.459 | 0.453 | 36 | 43 | 5.5 | 3360 |
| 3–a | *Pinus echinata* | 15 | 0.602 | 0.588 (14)* | 36 | 53 | 10 | 4625 |
| 3–c | (shortleaf pine) | 11 | 0.544 | 0.535 (10)* | 33 | 46 | 12 | 4477 |
| 3–e |  | 11 | 0.519 | 0.510 (10)* | 35 | 43 | 11 | 4110 |
| 3–h |  | 11 | 0.475 | 0.465 | 29 | 38 | 13 | 3840 |
|  | Ave. |  | 0.535 | 0.524 | 33 | 45 | 11.5 | 4263 |
| 4–a | *Pinus palustris* | 22 | 0.565 | 0.509 (21)* | 38 | 49 | 20 | 3752 |
| 4–c | (longleaf pine) | 20 | 0.572 | 0.541 | 36 | 46 | 21 | 4003 |
| 4–f |  | 15 | 0.555 | 0.509 | 40 |  | 20 | 3669 |
| 4–h |  | 14 | 0.521 | 0.473 (13)* | 29 | 38 | 21 | 3293 |
|  | Ave. |  | 0.553 | 0.508 | 35 |  | 20.5 | 3679 |
| 6–a | *Pinus palustris* | 12 | 0.569 | 0.542 | 44 | 44 | 24 | 4063 |
| 6–e | (longleaf pine) | 9 | 0.571 | 0.489 | 39 | 34 | 22 | 3977 |
| 6–i |  | 9 | 0.477 | 0.453 | 32 | 29 | 21 | 3172 |
|  | Ave. |  | 0.539 | 0.494 | 38 | 36 | 22 | 3737 |

* The number of specimens represented in the corrected values.

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[8] The specific gravity after correcting for resin content. These corrected values were used in all interpretations in this paper.

TABLE VI

RESULTS OF COMPRESSION TESTS AVERAGED BY BOLTS AND BY TREES—SEASONED. THE AVERAGE STRENGTH IS BASED UPON THE AREA REPRESENTED BY THE TESTS MADE AT VARIOUS DISTANCES FROM THE PITH

| Tree and bolt No. | Species | Number of tests | Percentage of moisture | Original specific gravity | Corrected specific gravity | Estimated percentage of summer wood | Measured percentage of summer wood | Rings per inch | Maximum stress #/sq. in. |
|---|---|---|---|---|---|---|---|---|---|
| 1–a | *Pinus Taeda* | 25 | 6.6 | 0.589 | 0.569 (17)* | 57 | 55 | 7.7 | 10677 |
| 1–d | (loblolly pine) | 22 | 7.0 | 0.500 | 0.499 (17)* | 34 | 38 | 7.5 | 9191 |
| 1–h | | 28 | 7.9 | 0.473 | 0.435 (12)* | 29 | 30 | 6.9 | 8658 |
| | Ave. | | 7.1 | 0.521 | 0.501 | 40 | 41 | 7.4 | 9508 |
| 2–a | *Pinus Taeda* | 28 | 8.0 | 0.596 | 0.576 (20)* | 52 | 53 | 5.4 | 11692 |
| 2–d | (loblolly pine) | 24 | 6.2 | 0.508 | 0.488 (14)* | 43 | 41 | 4.5 | 9512 |
| 2–h | | 24 | 7.7 | 0.495 | 0.479 (22)* | 30 | 35 | 4.0 | 8775 |
| | Ave. | | 7.3 | 0.533 | 0.514 | 41 | 43 | 4.6 | 9993 |

* The number of specimens represented in the corrected values.

summer wood[9] are given where a sufficient number of tests was made to justify a comparison. Where there were fewer tests the number is given in parentheses followed by an asterisk. The estimated summer wood was on the whole lower than the measured values.

These averages show particularly the variations in density and strength at the different heights in the tree. They also show to a certain degree the differences in strength shown by the various species. In the green condition *Pinus echinata* was consistently stronger than *Pinus palustris* which in turn was stronger than *Pinus Taeda* except for one bolt in tree 4 (fig. 3). The strength decreased from the base towards the top of the tree. The strongest material was in the lower bolts except in tree 4 where the strength reached a maximum in bolt *c* about 12 feet from the ground. In the lower part of the tree the strength fluctuated from bolt to bolt, but the maximum was invariably in the lower 12 to 15 feet in all three species. However, the maximum strength per unit weight was often between the 20- to 40-foot level in the trees. The seasoned material of trees 1 and 2 showed the same relationship (fig. 3).

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[9] The summer wood as measured under the microscope. Only the measured summer wood is given in the other tables and the text.

Tables VII (green material) and VIII (seasoned material) show results of individual tests and microscopic studies taken within each bolt. They show particularly the variations in properties which occur from the pith to the bark and to a certain extent on the opposite sides of a cross-section. In order to obtain a sample of the average material for microscopic study at least one series of specimens from the pith to the bark on the north side of each bolt was used. The north side was arbitrarily chosen since no one side was consistently weak or strong. In addition, the percentage of resin was determined for a large number of specimens on the other three sides of each bolt, and the specific gravity (corrected for resin content)

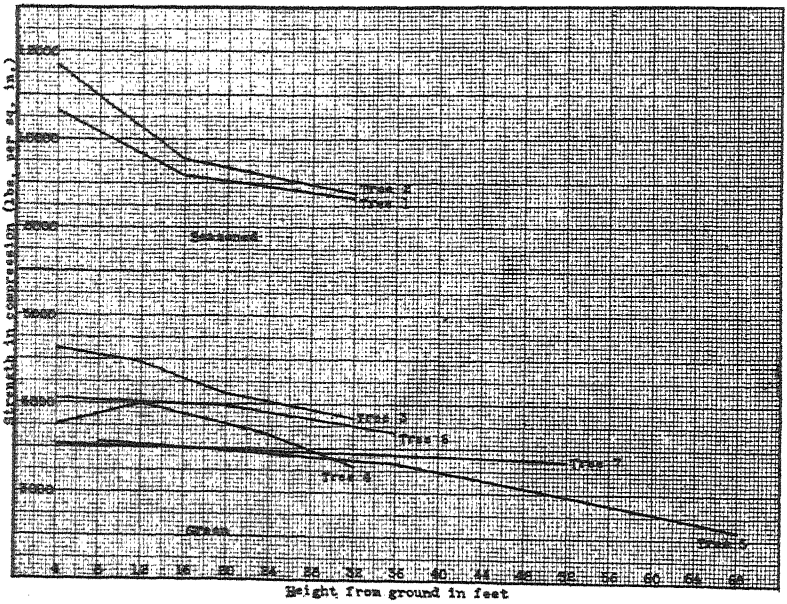

Fig. 3. The variation of strength with height in tree: below, the five trees tested green (trees 5 and 7, *Pinus Taeda*, loblolly pine, tree 3, *Pinus echinata*, shortleaf pine, and trees 4 and 6, *Pinus palustris*, longleaf pine); above, trees 1 and 2 (*Pinus Taeda*, loblolly pine) tested in the seasoned condition. The average strength of each bolt was obtained by evaluating the tests by the area represented in the cross-sections (tables V and VI).

plotted against the strength. The specimens showing unusual strength or weakness were then studied microscopically. By this method material having average or very high strength and very low strength for its specific gravity was included. More material would necessarily have included a greater number of variations but the maximum range for the material represented was covered.

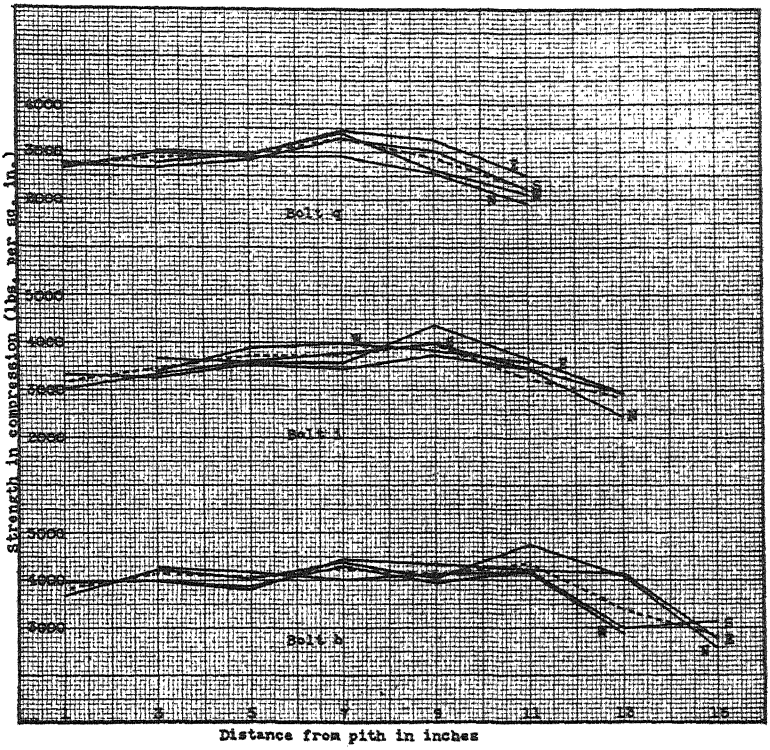

Fig. 4. Tree 5 (*Pinus Taeda*, loblolly pine), green. The solid lines represent the compression strength plotted against the distance from the pith for a single series of tests; the broken lines, the averages of all tests. Note how closely the average of all tests represents those plotted.

In the cross-section of tree 5 *(Pinus Taeda)* the strength increased from the region of the first annual rings towards the bark. It reached a maximum at about 11, 9, and 7 inches from the pith in bolts *b*, *i*, and *q*, respectively, after which it decreased to a minimum in the outer sapwood (fig. 4). The tra-

TABLE VII

RESULTS OF MICROSCOPIC STUDIES AND RESIN DETERMINATIONS, TOGETHER WITH THE COMPRESSION STRENGTH, OF THE INDIVIDUAL SPECIMENS OF FIVE TREES—GREEN

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| Tree 5—*Pinus Taeda* (loblolly pine) | | | | | | | | | |
| 5bN1 | 3680 | 0.494 | 2.7 | 34 | 44 | 10 | 3.0 | 6.90 | 1.53 |
| 5bN3 | 4240 | 0.547 | 2.4 | 32 | 53 | 6 | 3.5 | | 1.13 |
| 5bN5 | 4020 | 0.577 | 2.5 | 36 | 62 | 5 | 3.7 | | 1.13 |
| 5bN7 | 4380 | 0.595 | 1.9 | 33 | 63 | 5 | 4.0 | 8.51 | 1.74 |
| 5bN9 | 4040 | 0.574 | 2.0 | 35 | 60 | 4 | 4.3 | | 1.83 |
| 5bN11 | 4750 | 0.588 | 2.1 | | 65 | 8 | 4.5 | | 1.37 |
| 5bN12–1 | 4640 | 0.544 | 2.3 | 35 | 60 | 7 | | | 1.37 |
| 5bN13 | 4090 | 0.546 | 2.4 | 39 | 60 | 9 | 4.6 | | 1.23 |
| 5bN15 | 2570 | 0.428 | 2.6 | 104 | 53 | 23 | 4.6 | 9.72 | 1.27 |
| 5bN16–1 | 2520 | 0.450 | 2.5 | 125 | 50 | 14 | | | 1.59 |
| 5bS1 | 3970 | 0.480 | 1.8 | 36 | 54 | 9 | | | 1.71 |
| 5bS5 | 3880 | 0.572 | 1.9 | 32 | 63 | 5 | | | 1.22 |
| 5bS10–1 | 4450 | 0.559 | 1.7 | 34 | | 8 | | | |
| 5bS13 | 2990 | 0.481 | 1.3 | 85 | | 9 | | | |
| 5bS16–1 | 3230 | 0.407 | 2.5 | 111 | | 19 | | | |
| 5bE3 | 3990 | 0.571 | 8.0 | 29 | 52 | 6 | | | 1.20 |
| 5bE5 | 3840 | 0.584 | 1.7 | 35 | 57 | 5 | | 8.20 | 1.06 |
| 5bS3–6 | 3110 | 0.488 | 1.0 | 52 | | 11 | | | |
| 5bE15 | 2750 | 0.460 | 2.0 | 106 | 48 | 14 | | | 1.49 |
| 5bN3–3 | 4030 | 0.588 | 1.9 | 34 | 56 | 5 | | 9.75 | 0.88 |
| 5bW1–3 | 2870 | 0.464 | 2.6 | 99 | | 15 | | | |
| 5bN3–6 | 3050 | 0.483 | 2.4 | 89 | 51 | 13 | | | 1.48 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5iN1 | 3330 | 0.420 | 1.2 | 31 | 19 | 6 | 2.6 | 6.34 | 1.31 |
| 5iN3 | 3250 | 0.440 | 1.8 | 32 | 31 | 5 | 4.0 | | 1.14 |
| 5iN4–1 | 3610 | 0.462 | 0.4 | 33 | 38 | 5 | | | 1.24 |
| 5iN5 | 3520 | 0.466 | 1.7 | 30 | 42 | 6 | 4.3 | | 1.17 |
| 5iN6–1 | 3760 | 0.451 | 1.6 | 33 | 40 | 6 | | | 1.25 |
| 5iN7 | 3440 | 0.458 | 1.6 | 33 | 42 | 6 | 4.5 | 7.76 | 1.19 |
| 5iN8–1 | 3450 | 0.442 | 0.7 | 34 | 43 | 6 | | | 1.29 |
| 5iN9 | 3720 | 0.469 | 1.0 | 34 | 41 | 7 | 4.8 | | 1.22 |
| 5iN10–1 | 3930 | 0.451 | 1.0 | 34 | 43 | 8 | | 7.96 | 1.16 |
| 5iN11 | 3450 | 0.485 | 1.3 | 97 | 44 | 9 | 5.1 | | 0.92 |
| 5iN13 | 2450 | 0.404 | 1.5 | 144 | 34 | 25 | 5.2 | 7.74 | 1.67 |
| | | | | | | | | | |
| 5iS1 | 3000 | 0.403 | 3.2 | 29 | | 5 | | | |
| 5iS3 | 3280 | 0.443 | 1.3 | 34 | | 5 | | | |
| 5iS5 | 3590 | 0.460 | 1.1 | 34 | 32 | 6 | | | 1.06 |
| 5iS7 | 3780 | 0.464 | 1.0 | 34 | 40 | 6 | | | 1.12 |
| 5iS8–1 | 3990 | 0.496 | 1.1 | 32 | 41 | 7 | | | 1.49 |
| 5iS9 | 3960 | 0.489 | 1.0 | 34 | | 8 | | | |
| 5iS10–1 | 4130 | 0.492 | 2.0 | 34 | 39 | 9 | | | 1.63 |
| 5iS11 | 3470 | 0.446 | 1.4 | 42 | | 11 | | | |
| 5iS13 | 2910 | 0.429 | 2.2 | 145 | | 21 | | | |
| | | | | | | | | | |
| 5iE3 | 3660 | 0.445 | 1.7 | 33 | 35 | 6 | | | 1.14 |
| 5iS3–1 | 3590 | 0.455 | 1.9 | 33 | 33 | 6 | | | 1.29 |
| 5iS3–3 | 3940 | 0.494 | 1.6 | 33 | 42 | 7 | | | 1.26 |
| 5iE9 | 4390 | 0.486 | 1.5 | 31 | 45 | 7 | | | 1.26 |
| | | | | | | | | | |
| 5iW3 | 3380 | 0.422 | 1.0 | 33 | 33 | 6 | | | 1.13 |
| 5iW5 | 3870 | 0.456 | 1.0 | 33 | 40 | 6 | | | 1.17 |
| 5iN3–2 | 3940 | 0.467 | 1.7 | 33 | 42 | 6 | | | 1.22 |
| 5iW7 | 3950 | 0.477 | 1.6 | 35 | 42 | 7 | | | 1.32 |
| 5iN3–3 | 3850 | 0.448 | 4.0 | 32 | 42 | 7 | | 7.89 | 1.31 |
| 5iN3–4 | 3840 | 0.445 | 1.8 | 35 | 38 | 10 | | | 1.52 |

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* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

TABLE VII (Continued)

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| 5qN1 | 2665 | 0.378 | 5.4 | 30 | 17 | 4 | 2.5 | 6.18 | 1.19 |
| 5qN3 | 2980 | 0.403 | 2.3 | 32 | 30 | 5 | 3.8 | | 1.18 |
| 5qN5 | 2900 | 0.399 | 4.7 | 33 | 29 | 5 | 4.3 | 10.60 | 1.12 |
| 5qN7 | 2920 | 0.422 | 2.4 | 30 | 33 | 7 | 4.6 | | 1.42 |
| 5qN9 | 2560 | 0.419 | 2.0 | 45 | 32 | 11 | 4.7 | | 1.25 |
| 5qN11 | 1925 | 0.362 | 3.8 | 162 | 28 | 22 | 5.1 | 8.06 | 1.65 |
| 5qS1 | 2760 | 0.396 | 4.3 | 33 | | 4 | | | |
| 5qS3 | 2660 | 0.390 | 2.3 | 32 | | 5 | | | |
| 5qS5 | 2810 | 0.405 | 2.0 | 32 | | 6 | | | |
| 5qS7 | 3295 | 0.445 | 1.4 | 32 | 33 | 7 | | | 1.46 |
| 5qS8–1 | 3390 | 0.436 | 1.0 | 33 | 38 | 9 | | | 1.08 |
| 5qS9 | 3030 | 0.432 | 2.7 | 72 | | 9 | | | |
| 5qS11 | 2210 | 0.382 | 4.2 | 153 | | 15 | | | |
| 5qS12–1 | 2135 | 0.375 | 3.5 | 182 | 28 | 12 | | | 1.38 |
| 5qE3 | 2785 | 0.416 | 2.6 | 35 | | 6 | | | |
| 5qE5 | 2940 | 0.420 | 2.9 | 34 | | 5 | | | |
| 5qE7 | 3460 | 0.429 | 2.7 | 32 | 35 | 8 | | | 1.18 |
| 5qE9 | 3245 | 0.436 | 2.5 | 34 | | 9 | | | |
| 5qE11 | 2500 | 0.415 | 3.5 | 136 | 30 | 13 | | | 1.56 |
| 5qS3–5 | 2605 | 0.443 | 2.0 | 147 | 39 | 16 | | | 1.34 |
| 5qW3 | 3015 | 0.410 | 4.5 | 30 | | 6 | | | |
| 5qW5 | 2965 | 0.406 | 2.4 | 32 | | 6 | | | |
| 5qW7 | 3410 | 0.470 | 2.9 | 33 | | 9 | | | |
| 5qW9 | 2625 | 0.412 | 4.0 | 117 | | 12 | | | |
| 5qW11 | 2115 | 0.336 | 3.1 | 178 | | 22 | | | |

Tree 7—*Pinus Taeda* (loblolly pine)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7aN1 | 2805 | 0.437 | 1.4 | 39 | 34 | 5 | 3.0 | 7.98 | 1.12 |
| 7aN3 | 3245 | 0.449 | 1.9 | 39 | 40 | 4 | 3.9 | 9.06 | 1.20 |
| 7aN5 | 3390 | 0.468 | 1.0 | 128 | 40 | 6 | 4.5 | 8.94 | 1.29 |
| 7aN7 | 3695 | 0.500 | 1.1 | 107 | 49 | 7 | 4.8 | 7.81 | 1.25 |
| 7aS1 | 3565 | 0.497 | 1.7 | 36 | 52 | 5 | | | 1.03 |
| 7aS3 | 3450 | 0.504 | 0.8 | 109 | 50 | 6 | | | 1.03 |
| 7aS5 | 3480 | 0. | 1.0 | | 53 | 4 | | | 1.33 |
| 7aS7 | 3865 | 0.527 | 0.8 | 84 | 65 | 8 | | | 1.88 |
| 7aE3 | 3110 | 0.448 | 2.9 | 44 | 46 | 4 | | | 1.34 |
| 7aE5 | 3025 | 0.439 | 1.2 | 127 | 51 | 6 | | | 1.29 |
| 7aE7 | 3090 | 0.459 | 1.5 | 119 | 58 | 4 | | | 1.87 |
| 7aE9 | 3530 | 0.478 | 0.7 | 114 | 47 | 8 | | | 1.49 |
| 7aW3 | 3705 | 0.535 | 0.8 | 103 | 55 | 6 | | | 1.15 |
| 7aW5 | 3955 | 0.536 | 0.7 | 102 | 47 | 7 | | | 1.27 |
| 7aW7 | 3975 | 0.513 | 0.9 | 106 | 58 | 11 | | | 1.53 |
| 7gN1 | 3245 | 0.430 | 1.1 | 34 | 33 | 4 | 3.2 | 7.09 | 1.03 |
| 7gN3 | 3065 | 0.410 | 1.3 | 49 | 36 | 5 | 4.1 | 7.08 | 1.07 |
| 7gN5 | 3115 | 0.406 | 0.7 | 140 | 40 | 7 | 4.9 | 7.13 | 1.12 |
| 7gS1 | 2765 | 0.431 | 1.5 | 33 | 35 | 4 | | | 0.94 |
| 7gS3 | 3025 | 0.434 | 0.7 | 114 | 44 | 5 | | | 0.90 |
| 7gS5 | 3510 | 0.470 | 1.8 | 109 | 53 | 6 | | | 1.18 |
| 7gS7 | 3705 | 0.491 | 0.8 | 105 | 58 | 7 | | 6.34 | 1.31 |
| 7gE3 | 2960 | 0.422 | 4.0 | 33 | 48 | 3 | | | 0.90 |
| 7gE5 | 2810 | 0.420 | 1.0 | 120 | 41 | 5 | | | 1.10 |
| 7gE7 | 3580 | 0.476 | 0.8 | 123 | 45 | 5 | | | 1.00 |

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* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

TABLE VII (Continued)

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| Tree 7 (Continued) | | | | | | | | | |
| 7gW3 | 3580 | 0.483 | 1.3 | 106 | 46 | 5 | | | 0.95 |
| 7gW5 | 3725 | 0.482 | 1.3 | 120 | 50 | 7 | | | 1.33 |
| 7mN1 | 2915 | 0.399 | 1.4 | 45 | 28 | 4 | 3.0 | 7.50 | 0.92 |
| 7mN3 | 3050 | 0.426 | 1.0 | 147 | 36 | 9 | 4.1 | 7.60 | 1.18 |
| 7mN5 | 3420 | 0.455 | 1.2 | 134 | 44 | 10 | 4.8 | 7.43 | 1.37 |
| 7mS1 | 2955 | 0.399 | 1.5 | 34 | 18 | 4 | | | 1.03 |
| 7mS3 | 2945 | 0.418 | 8.2 | 33 | 34 | 3 | | | 1.07 |
| 7mS5 | 2835 | 0.415 | 1.0 | 126 | 32 | 4 | | | 1.03 |
| 7mS7 | 2990 | 0.437 | 1.0 | 137 | 44 | 7 | | 8.04 | 1.29 |
| 7mE3 | 2890 | 0.427 | 1.0 | 136 | 36 | 5 | | | 1.05 |
| 7mE5 | 3490 | 0.465 | 1.0 | 130 | 48 | 10 | | | 1.64 |
| 7mW3 | 3185 | 0.421 | 0.7 | 77 | 37 | 4 | | | 1.03 |
| 7mW5 | 3335 | 0.451 | 0.8 | 124 | 42 | 6 | | | 1.15 |
| Tree 3—*Pinus echinata* (shortleaf pine) | | | | | | | | | |
| 3aN2 | 5850 | 0.614 | 2.6 | 29 | 58 | 13 | 4.0 | 5.87 | 1.24 |
| 3aN4 | 5720 | 0.612 | 3.3 | 29 | 58 | 8 | 4.2 | 6.26 | 0.72 |
| 3aN6 | 4240 | 0.580 | 3.6 | 74 | 63 | 6 | 4.6 | 6.04 | 0.73 |
| 3aN8 | 4260 | 0.543 | 3.3 | 83 | 52 | 10 | 4.9 | 6.37 | 0.71 |
| 3aN10 | 4150 | 0.542 | 1.4 | 93 | 51 | 14 | 4.9 | 6.50 | 0.97 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3aS2 | 4760 | 0.528 | 3.0 | 32 | 44 | 11 | 3.1 | | 0.80 |
| 3aS4 | 4400 | 0.549 | 3.3 | 54 | 45 | 9 | 4.2 | | 0.92 |
| 3aS6 | 4140 | 0.536 | 2.4 | 97 | 46 | 14 | 4.7 | | 1.04 |
| 3aE3 | 5900 | 0.684 | 1.3 | 30 | 59 | 14 | 4.1 | | 0.84 |
| 3aE5 | 5370 | 0.685 | 3.5 | 33 | 57 | 15 | | | 0.94 |
| 3aE7 | 4950 | 0.700 | 2.1 | 30 | 61 | 9 | 4.3 | | 0.94 |
| 3aE9 | 4760 | 0.598 | 3.0 | 32 | 57 | 13 | | | 1.08 |
| 3aW3 | 3920 | 0.526 | 1.9 | 103 | 45 | 15 | 3.8 | | 0.92 |
| 3aW5 | 4240 | 0.537 | 2.8 | 84 | 49 | 15 | 4.2 | | 1.01 |
| 3eN4 | 4960 | 0.557 | 2.6 | 33 | 47 | 11 | 4.7 | 5.82 | 0.71 |
| 3eN6 | 4780 | 0.566 | 2.4 | 34 | 48 | 8 | 4.9 | 6.33 | 0.92 |
| 3eN8 | 4280 | 0.555 | 0.9 | 96 | 46 | 9 | 5.0 | 6.23 | 0.69 |
| 3eN10 | 4380 | 0.531 | 0.9 | 109 | 45 | 10 | 5.1 | 6.30 | 0.70 |
| 3cS2 | 4260 | 0.493 | 3.0 | 30 | 44 | 18 | | | 1.07 |
| 3cS4 | 4150 | 0.506 | 1.5 | 91 | 48 | 13 | 5.0 | | 1.07 |
| 3cS6 | 4120 | 0.527 | 1.7 | 107 | 48 | 18 | | | |
| 3cE3 | 5090 | 0.570 | 1.6 | 113 | 50 | 12 | | | |
| 3cE5 | 4600 | 0.557 | 1.6 | 111 | 50 | 10 | 5.1 | | |
| 3cW3 | 3930 | 0.487 | 1.5 | 34 | 46 | 12 | | | |
| 3eN2 | 4220 | 0.506 | 3.0 | 40 | 50 | 15 | 3.8 | 5.94 | 0.83 |
| 3eN4 | 4660 | 0.529 | 2.9 | 45 | 48 | 9 | 4.7 | 5.83 | 0.80 |
| 3eN6 | 4210 | 0.518 | 2.6 | 82 | 40 | 11 | 4.9 | 6.27 | 0.89 |
| 3eN8 | 3950 | 0.508 | 2.5 | 95 | 44 | 10 | 5.0 | 6.85 | 0.78 |

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* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

TABLE VII (Continued)

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| Tree 3 (Continued) | | | | | | | | | |
| 3eS4 | 4080 | 0.509 | 1.0 | 107 | 45 | 10 | | | 0.71 |
| 3eS6 | 4000 | 0.527 | 1.1 | 94 | 44 | 15 | | | 0.73 |
| 3eE3 | 3980 | 0.533 | 1.2 | 93 | 40 | 15 | | | |
| 3eE5 | 4180 | 0.537 | 0.9 | 100 | 48 | 10 | | | |
| 3eW3 | 3230 | 0.458 | 2.3 | 33 | 40 | 9 | | | 0.70 |
| 3eS4–1 | 3520 | 0.474 | 2.1 | 60 | 35 | 10 | | | |
| 3hN2 | 3830 | 0.447 | 3.9 | 29 | 23 | 11 | 3.8 | 6.08 | 0.89 |
| 3hN4 | 4070 | 0.500 | 1.5 | 88 | 40 | 10 | 4.8 | 5.96 | 0.75 |
| 3hN6 | 3780 | 0.486 | 1.6 | 108 | 39 | 10 | 5.0 | 5.82 | 0.60 |
| 3hS2 | 3290 | 0.402 | 3.9 | 32 | 14 | 11 | | | 0.78 |
| 3hS4 | 3680 | 0.451 | 3.7 | 47 | 44 | 12 | | | 0.83 |
| 3hS6 | 3840 | 0.473 | 2.4 | 109 | 39 | 21 | | | 0.74 |
| 3hE3 | 4110 | 0.470 | 1.0 | 31 | 41 | 12 | | | |
| 3hE5 | 4210 | 0.508 | 1.6 | 97 | 47 | 17 | | | |
| 3hE7 | 3970 | 0.501 | 1.0 | 100 | 43 | 14 | | | |
| 3hW3 | 3230 | 0.434 | 1.6 | 43 | 40 | 10 | | | 0.59 |
| 3hW5 | 3110 | 0.448 | 1.5 | 127 | 35 | 9 | | | |

Tree 4—*Pinus palustris* (longleaf pine)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4aN1 | 4020 | 0.530 | 2.9 | 35 | | 40 | | | |
| 4aN2 | 5330 | 0.607 | 6.7 | 29 | 46 | 33 | 4.4 | 6.46 | 1.07 |
| 4aN3 | 5230 | 0.593 | 8.0 | 29 | | 20 | | | |
| 4aN4 | 5780 | 0.654 | 5.1 | 32 | 60 | 15 | 4.8 | 7.00 | 1.10 |
| 4aN5 | 4260 | 0.524 | 7.8 | 54 | | 15 | | | |
| 4aN6 | 4900 | 0.577 | 12.0 | 34 | 45 | 16 | 5.0 | 7.17 | 1.21 |
| 4aN7 | 3420 | 0.531 | 1.9 | 110 | | 18 | | | |
| 4aN8 | 3520 | 0.500 | 3.2 | 116 | 45 | 20 | 5.1 | 7.95 | 1.34 |
| 4aS1 | 4310 | 0.554 | 12.3 | 26 | 35 | 27 | | | 1.00 |
| 4aS2 | 4100 | 0.502 | 11.2 | 32 | | 29 | 4.2 | | |
| 4aS3 | 3020 | 0.508 | 2.3 | 124 | | 19 | | | |
| 4aS4 | 3000 | 0.486 | 2.3 | 128 | | 20 | 4.7 | | |
| 4aS5 | 2740 | 0.499 | 2.4 | 114 | 45 | 15 | | | 1.57 |
| 4aS6 | 2830 | 0.468 | 4.6 | 120 | | 11 | 4.8 | | |
| 4aE3 | 4840 | 0.623 | 9.3 | 26 | 49 | 17 | 4.5 | | 1.13 |
| 4aE4 | 2960 | 0.457 | 4.1 | 126 | | 24 | | | |
| 4aE5 | 3560 | 0.490 | 3.0 | 118 | | 20 | 5.0 | | |
| 4aW3 | 3830 | 0.508 | 6.9 | 86 | | 22 | 4.8 | | |
| 4aW4 | 4260 | 0.543 | 9.3 | 39 | | 19 | | | |
| 4aW5 | 3460 | 0.509 | 1.9 | 113 | | 18 | | | |
| 4aW6 | 3600 | 0.554 | 1.1 | 99 | | 14 | | | |
| 4cN1 | 4570 | 0.538 | 4.9 | 28 | 39 | 36 | | | 1.08 |
| 4cN2 | 4670 | 0.652 | 4.5 | 22 | 40 | 33 | 4.0 | 7.59 | 1.22 |
| 4cN3 | 4420 | 0.557 | 6.8 | 33 | 52 | 24 | | | 1.27 |
| 4cN4 | 4970 | 0.581 | 7.1 | 29 | 53 | 20 | 4.9 | 7.20 | 1.27 |
| 4cN5 | 3690 | 0.508 | 3.1 | 107 | 57 | 21 | | | 1.17 |
| 4cN6 | 3440 | 0.531 | 3.4 | 108 | 35 | 27 | 5.2 | 7.63 | 1.26 |

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* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

TABLE VII (Continued)

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| Tree 4 (Continued) | | | | | | | | | |
| 4cS1 | 4440 | 0.564 | 3.9 | 29 | | 28 | | | |
| 4cS2 | 4220 | 0.541 | 9.5 | 27 | | 23 | 4.6 | | |
| 4cS3 | 3920 | 0.503 | 10.6 | 69 | | 19 | | | |
| 4cS4 | 3840 | 0.567 | 4.2 | 85 | | 18 | 4.8 | | |
| 4cS5 | 3990 | 0.502 | 2.2 | 104 | 51 | 13 | | | 0.89 |
| 4cS6 | 4000 | 0.525 | 1.3 | 103 | | 12 | 5.1 | | |
| 4cE3 | 5230 | 0.620 | 2.5 | 29 | | 16 | 4.7 | | |
| 4cE4 | 4440 | 0.545 | 10.4 | 25 | | 15 | | | |
| 4cE5 | 3810 | 0.518 | 6.6 | 102 | | 28 | 5.2 | | |
| 4cE6 | 3440 | 0.491 | 5.3 | 116 | | 20 | | | |
| 4cW3 | 4040 | 0.525 | 6.1 | 79 | | 23 | 4.8 | | |
| 4cW4 | 3720 | 0.475 | 6.3 | 86 | | 25 | | | |
| 4cW5 | 4060 | 0.545 | 4.9 | 96 | | 16 | 5.0 | | |
| 4cW6 | 4040 | 0.536 | 5.2 | 97 | | 14 | | | |
| 4fN1 | 4140 | 0.563 | 22.4 | 23 | | 22 | | | |
| 4fN2 | 2320 | 0.545 | 29.1 | 23 | 37 | 29 | | | 1.17 |
| 4fN3 | 3460 | 0.497 | 2.2 | 77 | | 22 | | | |
| 4fN4 | 3970 | 0.518 | 4.9 | 54 | 38 | 21 | | | 0.92 |
| 4fN5 | 3860 | 0.539 | 1.2 | 100 | | 13 | | | |
| 4fS1 | 4170 | 0.541 | 17.3 | 27 | 38 | 25 | | | 1.14 |
| 4fS2 | 4160 | 0.542 | 11.0 | 28 | | 16 | | | |
| 4fS3 | 3080 | 0.446 | 2.4 | 111 | | 26 | | | |
| 4fS4 | 3150 | 0.460 | 1.4 | 116 | | 22 | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4fE3 | 4110 | 0.524 | 1.9 | 57 | | 23 | | | |
| 4fE4 | 3220 | 0.462 | 2.4 | 94 | | 26 | | | |
| 4fE5 | 3330 | 0.483 | 1.5 | 116 | | 23 | | | |
| | | | | | | | | | |
| 4fW3 | 3690 | 0.504 | 2.7 | 81 | | 18 | | | |
| 4fW4 | 3560 | 0.483 | 3.3 | 66 | | 19 | | | |
| 4fW6 | 3820 | 0.538 | 0.9 | 97 | | 14 | | | |
| | | | | | | | | | |
| 4hN1 | 3150 | 0.528 | 23.5 | 23 | 41 | 22 | | 5.80 | 1.15 |
| 4hN2 | 3930 | (0.601) | | 27 | 39 | 20 | 4.1 | | 0.85 |
| 4hN3 | 2890 | 0.500 | 7.7 | 36 | 36 | 29 | | 6.08 | 1.06 |
| 4hN4 | 3630 | 0.554 | 7.4 | 69 | 37 | 22 | 5.2 | | 0.96 |
| | | | | | | | | | |
| 4hS2 | 3350 | 0.470 | 10.9 | 32 | | 18 | 4.3 | | |
| 4hS3 | 2960 | 0.448 | 4.8 | 125 | | 21 | | | |
| 4hS4 | 3040 | 0.436 | 1.2 | 137 | 38 | 24 | 5.1 | | 1.15 |
| | | | | | | | | | |
| 4hE3 | 3450 | 0.471 | 5.7 | 79 | | 17 | | | |
| 4hE4 | 3030 | 0.418 | 4.1 | 127 | | 23 | 5.0 | | |
| | | | | | | | | | |
| 4hW3 | 3270 | 0.457 | 4.6 | 118 | | 22 | 5.0 | | |
| 4hW4 | 3180 | 0.438 | 8.1 | 83 | | 28 | | | |
| 4hW5 | 3350 | 0.478 | 5.3 | 115 | | 20 | | | |
| 4hW6 | 3300 | 0.471 | 3.5 | 65 | | 16 | | | |

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* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

TABLE VII (Continued)

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| Tree 6—*Pinus palustris* (longleaf pine) | | | | | | | | | |
| 6aN1 | 6300 | 0.620 | 8.6 | 25 | 47 | 42 | 4.4 | 6.14 | 1.45 |
| 6aN3 | 4250 | 0.479 | 4.1 | 91 | 45 | 12 | 4.7 | 6.34 | 0.90 |
| 6aN5 | 3570 | 0.507 | 3.0 | 107 | 39 | 17 | 4.8 | 8.26 | 1.82 |
| 6aS1 | 5365 | 0.575 | 5.0 | 30 | 38 | 44 | | | 1.48 |
| 6aS3 | 5830 | 0.580 | 8.2 | 35 | 43 | 39 | | | 1.81 |
| 6aS5 | 4270 | 0.536 | 1.9 | 97 | 46 | 10 | | | 1.15 |
| 6aS7 | 3770 | 0.498 | 1.5 | 115 | 35 | 20 | 4.9 | 8.11 | 1.41 |
| 6aE3 | 4040 | 0.514 | 1.9 | 95 | 44 | 16 | | | 1.14 |
| 6aE5 | 4285 | 0.542 | 2.6 | 97 | 45 | 22 | | | 1.87 |
| 6aW3 | 5830 | 0.622 | 10.9 | 26 | 59 | 30 | | | 1.39 |
| 6aW5 | 4190 | 0.522 | 2.9 | 86 | 45 | 12 | | | 1.10 |
| 6aW7 | 3655 | 0.513 | 2.5 | 107 | 39 | 21 | | | 1.59 |
| 6eN1 | 3800 | 0.520 | 4.5 | 32 | 22 | 36 | 4.0 | 5.79 | 1.69 |
| 6eN3 | 4800 | 0.529 | 6.2 | 30 | 36 | 41 | 4.7 | 5.70 | 1.51 |
| 6eN5 | 3830 | 0.488 | 4.7 | 72 | 33 | 16 | 5.0 | 6.96 | 1.32 |
| 6eS1 | 4000 | 0.493 | 3.1 | 88 | 36 | 15 | | | 0.66 |
| 6eS3 | 3290 | 0.468 | 3.4 | 126 | 30 | 18 | | | 1.24 |
| 6eS5 | 3540 | 0.480 | 2.5 | 126 | 35 | 16 | | | 1.49 |
| 6eE3 | 3565 | 0.473 | 2.5 | 105 | 32 | 14 | | | 0.96 |
| 6eE5 | 4740 | 0.555 | 1.7 | 95 | 52 | 13 | | | 1.08 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6eW3 | 3670 | 0.482 | 5.2 | 85 | 28 | 25 | | | 0.99 |
| 6iN1 | 4265 | 0.525 | 15.7 | 27 | 26 | 38 | 4.5 | 6.03 | 1.32 |
| 6iN3 | 2675 | 0.403 | 9.2 | 100 | 19 | 19 | 4.8 | 6.33 | 1.07 |
| 6iN5 | 2755 | 0.407 | 4.0 | 157 | 25 | 26 | 5.0 | 8.41 | 1.65 |
| 6iS1 | 4825 | 0.495 | 11.8 | | 45 | 17 | | | 1.01 |
| 6iS3 | 3840 | 0.506 | 3.3 | 65 | 33 | 14 | | | 0.69 |
| 6iS5 | 2865 | 0.409 | 3.9 | 155 | 23 | 21 | | | 1.55 |
| 6iE3 | 3480 | 0.457 | 4.8 | 80 | 31 | 13 | | | 0.73 |
| 6iE5 | 3425 | 0.472 | 2.0 | 124 | 33 | 22 | | | 1.20 |
| 6iW3 | 2745 | 0.404 | 2.3 | 148 | 25 | 16 | | | 1.03 |

* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

TABLE VIII

RESULTS OF MICROSCOPIC STUDIES AND RESIN DETERMINATIONS ON THE INDIVIDUAL SPECIMENS—SEASONED

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| Tree 1—*Pinus Taeda* (loblolly pine) | | | | | | | | | |
| 1aN1 | 6430 | 0.526 | 5.4 | 6.5 | 35 | 3 | | | |
| 1aN2 | 6750 | 0.402 | 11.9 | 8.4 | 29 | 3 | 2.9 | 8.92 | 1.32 |
| 1aN3 | 8830 | 0.493 | 2.3 | 6.8 | 55 | 10 | | | |
| 1aN4 | 8770 | 0.526 | 2.4 | 6.8 | 59 | 10 | 4.0 | 8.82 | 1.61 |
| 1aN5 | 9870 | 0.566 | 2.0 | 7.1 | 65 | 6 | | | |
| 1aN6 | 9210 | 0.562 | 2.1 | 7.0 | 59 | 6 | 4.3 | 9.41 | 1.68 |
| 1aN7 | 9300 | 0,606 | 0.9 | 7.1 | 70 | 7 | | 10.25 | 1.62 |
| 1aN8 | 8720 | 0.597 | 2.3 | 7.2 | 65 | 6 | 4.6 | 10.29 | 1.89 |
| 1aS2 | 8730 | 0.593 | 3.7 | 6.0 | 38 | 4 | | 9.16 | 1.27 |
| 1aS4 | 12460 | 0.652 | 3.0 | 6.2 | 68 | 11 | | | 1.58 |
| 1aS5 | 14370 | 0.701 | 1.2 | 6.7 | 64 | 11 | | | 1.62 |
| 1aS6 | 13620 | 0.653 | 2.7 | 6.6 | 60 | 9 | | | 1.60 |
| 1aE3 | 10000 | 0.653 | 3.0 | 6.9 | | 10 | | | |
| 1aE5 | 10840 | 0.554 | 2.4 | 6.8 | | 7 | | | |
| 1aE7 | 9500 | 0.506 | 2.7 | 6.7 | | 8 | | | |
| 1aW4 | 9470 | 0.540 | 3.0 | 6.4 | 55 | 10 | | | 1.35 |
| 1aW5 | 13120 | 0.638 | 2.2 | 6.5 | 60 | 7 | | | 1.27 |
| 1dN1 | 6440 | 0.404 | 2.0 | 6.7 | 11 | 3 | | | |
| 1dN2 | 6320 | 0.402 | 2.3 | 7.3 | 11 | 3 | 2.9 | 9.35 | 1.25 |
| 1dN4 | 7760 | 0.452 | 1.2 | 7.2 | 40 | 7 | 4.2 | 7.94 | 1.10 |
| 1dN6 | 8580 | 0.501 | 1.3 | 7.3 | 46 | 7 | 4.8 | 8.32 | 1.05 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1dS2 | 6620 | 0.441 | 3.8 | 6.7 | 11 | 3 | | | 1.26 |
| 1dS3 | 10280 | 0.501 | 1.2 | 6.6 | 43 | 6 | | | 1.26 |
| 1dS4 | 10430 | 0.541 | 1.8 | 6.8 | 50 | 8 | | | 1.30 |
| 1dS5 | 11960 | 0.571 | 1.0 | 6.9 | 50 | 11 | | | 1.26 |
| 1dS6 | 13100 | 0.615 | 1.6 | 6.9 | 57 | 11 | | | 1.72 |
| 1dE3 | 8570 | 0.482 | 1.4 | 7.5 | | 10 | | | |
| 1dE4 | 10320 | 0.503 | 1.1 | 7.3 | 43 | 10 | | | 1.08 |
| 1dE5 | 10260 | 0.500 | 1.4 | 7.3 | 48 | 7 | | 8.54 | 1.40 |
| 1dE6 | 9940 | 0.484 | 1.0 | 7.3 | 47 | 8 | | 8.08 | 1.40 |
| 1dE7 | 8390 | 0.470 | 1.7 | 8.5 | | 9 | 5.0 | | |
| 1dW3 | 10920 | 0.509 | 1.1 | 6.9 | 45 | 10 | | 7.34 | 1.40 |
| 1dW5 | 11250 | 0.562 | 1.2 | 6.6 | | 11 | | | |
| 1dW6 | 11380 | 0.562 | 1.1 | 6.4 | 53 | 9 | | | 1.50 |
| 1hN1 | 7240 | 0.430 | 2.4 | 8.0 | | 5 | | | |
| 1hN2 | 5950 | 0.382 | 5.5 | 8.2 | 12 | 3 | 3.0 | 7.99 | 1.26 |
| 1hN4 | 7010 | 0.440 | 1.4 | 8.4 | 33 | 5 | 4.2 | 7.85 | 0.82 |
| 1hN6 | 8190 | 0.476 | 1.5 | 8.2 | 37 | 7 | 4.9 | 8.03 | 1.24 |
| 1hS1 | 6390 | 0.428 | 5.2 | 7.8 | 21 | 3 | | | 0.88 |
| 1hS2 | 6790 | 0.438 | 2.9 | 7.7 | 21 | 4 | | | 1.02 |
| 1hS4 | 9660 | 0.491 | 1.5 | 7.5 | 44 | 6 | | | 1.09 |
| 1hS6 | 8510 | 0.458 | 0.8 | 7.6 | 43 | 9 | | | 1.20 |
| 1hE3 | 7600 | 0.444 | 1.1 | 7.9 | | 6 | | | |
| 1hE5 | 8610 | 0.448 | 2.2 | 7.9 | | 9 | | | |
| 1hW3 | 6690 | 0.468 | 1.9 | 7.7 | | 5 | | | |
| 1hW5 | 10100 | 0.510 | 1.3 | 7.9 | | 12 | | | |

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* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

Table VIII (Continued)

| Specimen | Maximum stress #/sq. in. | Specific gravity* | Percentage of resin | Percentage of moisture | Percentage of summer wood† | Rings/in. | Tracheid length in mm. | Percentage of area taken up by rays | Percentage of area taken up by resin ducts |
|---|---|---|---|---|---|---|---|---|---|
| Tree 2—*Pinus Taeda* (loblolly pine) | | | | | | | | | |
| 2aN2 | 6500 | 0.455 | 4.1 | 10.3 | 31 | 3 | 2.8 | 8.75 | 1.86 |
| 2aN4 | 11330 | 0.610 | 1.6 | 9.9 | 58 | 6 | 3.7 | 8.66 | 2.08 |
| 2aN5 | 13940 | 0.641 | 0.5 | 6.8 | 60 | 7 | | | 1.65 |
| 2aN6 | 12130 | 0.591 | 1.1 | 9.9 | 62 | 7 | 4.4 | 9.98 | 1.32 |
| 2aN9 | 13340 | 0.619 | 0.6 | 10.1 | 63 | 7 | 4.9 | 9.42 | 1.47 |
| 2aS1 | 6760 | 0.412 | 13.0 | 9.7 | 17 | 3 | | | 2.38 |
| 2aS2 | 9000 | 0.555 | 10.0 | 8.7 | 35 | 4 | | | 2.25 |
| 2aS3 | 8160 | 0.527 | 4.7 | 7.0 | 33 | 3 | | | 1.73 |
| 2aS4 | 9870 | 0.566 | 7.8 | 11.1 | 50 | 3 | | | 2.03 |
| 2aS5 | 12060 | 0.578 | 1.0 | 7.0 | 57 | 5 | | | 1.52 |
| 2aS6 | 12400 | 0.620 | 1.4 | 10.4 | 60 | 5 | | | 1.75 |
| 2aS8 | 12820 | 0.617 | 1.3 | 9.5 | 60 | 6 | | | 1.60 |
| 2aE3 | 11800 | 0.595 | 1.6 | 6.0 | 55 | 5 | | | 1.54 |
| 2aE5 | 11330 | 0.621 | 1.7 | 7.2 | 60 | 5 | | | 1.44 |
| 2aE6 | 9940 | 0.573 | 1.6 | 7.1 | 63 | 5 | | | 1.22 |
| 2aE7 | 10560 | 0.623 | 1.9 | 7.2 | 65 | 5 | | 9.84 | 1.88 |
| 2aE8 | 9650 | 0.578 | 1.2 | 7.6 | 65 | 6 | | | 1.90 |
| 2aW3 | 11600 | 0.552 | 1.7 | 7.2 | 50 | 5 | | | 1.54 |
| 2aW5 | 13000 | 0.628 | 2.2 | 7.0 | 65 | 6 | | | 1.65 |
| 2aW7 | 13000 | 0.623 | 1.9 | 7.0 | 62 | 10 | | | 1.83 |
| 2dN1 | 6100 | 0.434 | 21.2 | 8.3 | 17 | 2 | | | 2.05 |
| 2dN2 | 7170 | 0.427 | 3.7 | 6.6 | 30 | 2 | 3.0 | 8.02 | 1.51 |
| 2dN4 | 7800 | 0.466 | 0.9 | 6.1 | 48 | 3 | 3.7 | 7.81 | 1.58 |
| 2dN5 | 8010 | 0.524 | 1.8 | 6.2 | 45 | 5 | | | 1.61 |
| 2dN6 | 8650 | 0.516 | 1.1 | 6.5 | 50 | 4 | 4.5 | 8.65 | 1.40 |
| 2dN8 | 8430 | 0.500 | 0.7 | 6.4 | 50 | 5 | 5.0 | 9.59 | 1.47 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2dS2 | 6700 | 0.446 | 15.4 | 6.7 | 15 | 3 | | | 3.15 |
| 2dS4 | 10830 | 0.519 | 0.5 | 6.2 | 52 | 5 | | | 1.92 |
| 2dS6 | 12150 | 0.552 | 0.9 | 6.0 | 52 | 6 | | 9.15 | 2.02 |
| 2dE3 | 8370 | 0.486 | 0.5 | 5.8 | | 4 | | | |
| 2dE5 | 8980 | 0.533 | 0.8 | 5.9 | | 4 | | | |
| 2dE7 | 9260 | 0.526 | 0.5 | 5.9 | | 7 | | | |
| 2dW3 | 9960 | 0.514 | 1.2 | 5.5 | | 4 | | | |
| 2dW5 | 12270 | 0.502 | 1.4 | 7.0 | 54 | 6 | | | 1.61 |
| 2hN1 | 6240 | 0.376 | 20.8 | 8.7 | 20 | 3 | | | 2.50 |
| 2hN2 | 7000 | 0.452 | 6.8 | 7.7 | 20 | 2 | 3.1 | 8.36 | 1.34 |
| 2hN3 | 8140 | 0.422 | 3.9 | 8.0 | 26 | 2 | | 7.88 | 1.85 |
| 2hN4 | 7910 | 0.433 | 1.8 | 7.7 | 30 | 3 | 4.0 | 7.88 | 1.85 |
| 2hN5 | 9260 | 0.472 | 2.3 | 7.7 | 33 | 3 | | | 1.95 |
| 2hN6 | 8360 | 0.454 | 1.0 | 7.5 | 37 | 3 | 4.5 | 7.85 | 1.71 |
| 2hN8 | 10720 | 0.511 | 0.9 | 6.6 | 49 | 8 | 5.1 | 9.75 | 1.70 |
| 2hS1 | 6820 | 0.456 | 5.5 | 7.4 | 20 | 2 | | | 1.66 |
| 2hS2 | 7520 | 0.455 | 9.0 | 8.1 | 21 | 3 | | | 1.82 |
| 2hS3 | 9750 | 0.495 | 1.0 | 7.8 | 43 | 4 | | | 1.49 |
| 2hS4 | 9550 | 0.506 | 1.0 | 7.3 | 42 | 5 | | | 1.46 |
| 2hS5 | 10440 | 0.524 | 2.0 | 7.3 | 47 | 5 | | | 1.41 |
| 2hS6 | 10400 | 0.522 | 0.9 | 7.3 | 48 | 6 | | | 1.59 |
| 2hE3 | 7220 | 0.444 | 1.2 | 7.7 | 30 | 2 | | | 1.54 |
| 2hE4 | 6520 | 0.455 | 2.6 | 8.1 | 34 | 3 | | | 1.60 |
| 2hE5 | 7450 | 0.510 | 1.1 | 7.7 | 32 | 3 | | | 1.71 |
| 2hE6 | 7780 | 0.524 | 2.3 | 7.7 | 56 | 3 | | 9.61 | 2.20 |
| 2hE7 | 7680 | 0.504 | 1.4 | 7.7 | 37 | 6 | | | 1.49 |
| 2hE8 | 7250 | 0.501 | 2.2 | 7.8 | 40 | 7 | | | 1.64 |
| 2hW3 | 8270 | 0.477 | 1.4 | 7.8 | | 3 | | | |
| 2hW4 | 7970 | 0.428 | 1.8 | 8.8 | 32 | 3 | | | 1.86 |
| 2hW6 | 9720 | 0.533 | 1.0 | 7.6 | | 6 | | | |

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* The specific gravity as reported here was corrected for resin content.

† The percentage of summer wood was determined by measuring the rings under the microscope.

cheid length and the density increased with the strength to a maximum, after which the density decreased with the strength, but the tracheid length only fluctuated within small limits. The resin ducts and to a certain extent the area taken up by the rays increased in this weak material of the outer sapwood. There were certain fluctuations in strength on the opposite sides of the cross-section, as well as in side-matched specimens from the same side due to the presence of torquimural and crooked tracheids and an accumulative effect of minor defects and injuries caused by strain in the living tree, but any given series of specimens from the pith to the periphery, when plotted, resembled in general any other series from the same bolt or the average of all of them. In each of the three bolts (*b*, *i*, and *q*) there were 8 series of specimens tested from the inner portion of the tree to the periphery (see fig. 1 for the relative positions of the 8 series of specimens). Four series of tests were plotted in fig. 4, together with the average of all 8 series. The agreement was very close at all points except bolt *i*, 11 inches from the pith. In this tree the growth rate was medium to rapid for the first 7–11 inches from the center, depending upon the bolt, thus placing the region of greatest density and strength some distance from the pith. The outer portion was of very slow growth and low density and strength. Figure 5, for tree 7 *(Pinus Taeda)* shows an increase of strength from the pith to the periphery. This tree, being much younger than tree 5, did not show a decline of strength in the outer sapwood.

The average strength decreased from the inner specimens towards the periphery in bolt *a* of tree 3 *(Pinus echinata)* and remained practically constant in bolts *c* and *e*, with a slight increase in the same direction in bolt *h* (fig. 6). The growth rate was very slow in the first 2–4 inches in bolt *a*, after which it increased at a moderate rate, but at the higher levels the growth rate was more rapid in the inner heartwood and the region of greatest strength was therefore farther from the pith.

The wide fluctuations in strength at a given distance from the pith in this and the two following trees were due to the asymmetric growth and crookedness of the trees, which made it impossible to obtain side-matched specimens from the same

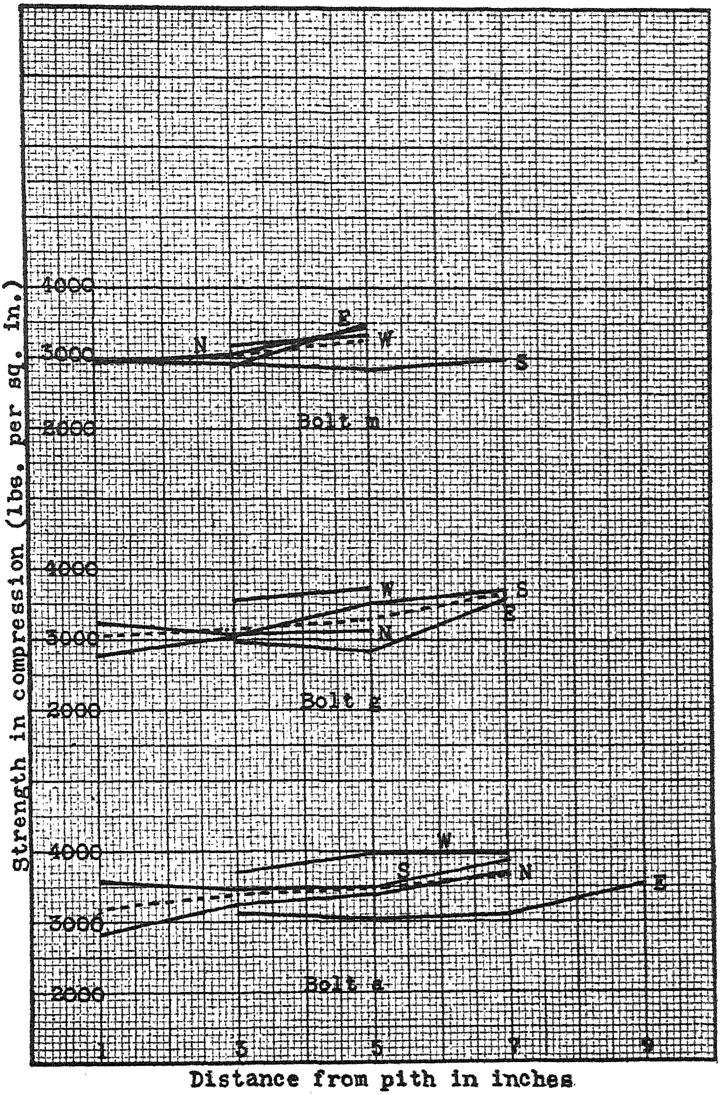

Fig. 5. Tree 7 (*Pinus Taeda,* loblolly pine), green. The solid lines represent the compression strength plotted against the distance from the pith for a single series of tests. The broken lines, the averages of these tests. Note that the average strength increased from the pith towards the periphery of the stem in all three bolts.

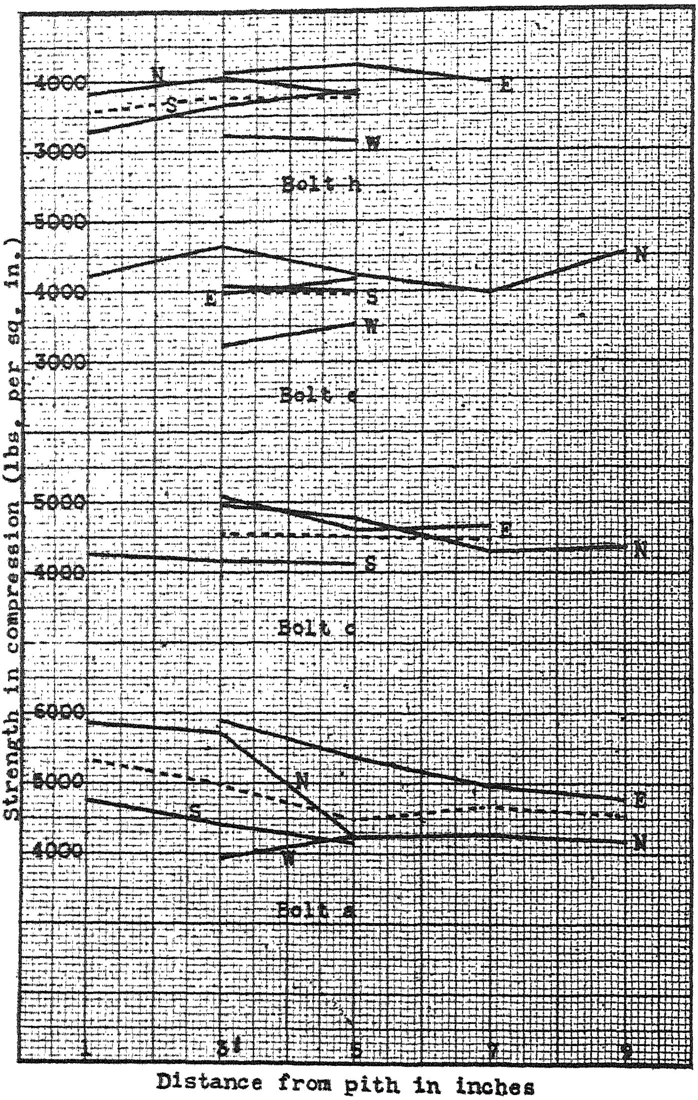

Fig. 6. Tree 3 (*Pinus echinata,* shortleaf pine), green. The solid lines represent the compression strength plotted against the distance from the pith; the broken lines, the averages of these tests. This tree was both crooked and asymmetrical, which accounts for the unequal number of tests on the different sides.

growth rings, as well as to the variations in the structure on the opposite sides. In the side having the slower growth the specimens would contain material laid down 20-40 years after that in the specimens on the opposite side, in the more rapid growth. Furthermore, areas of torquimural and crooked tracheids often occurred on one side, as opposed to straight concentrimural tracheids on the opposite side.

The *Pinus palustris* trees 4 and 6 were of very slow growth, especially for the first 2–4 inches along the radii (table I). In cutting the test sticks the pith and often the first rings containing the short tracheids, numerous resin ducts and wood rays were cut away. The result was that the maximum strength usually was within the first specimens around the pith. The average strength decreased then from this region towards the periphery of the stem (figs. 7 and 8), but occasional strong specimens occurred in the medium to outer portion of the trees. This was partly due to the impossibility of cutting directly through the pith in the crooked bolts, when the pith was thrown within a specimen which caused it to be weaker than its neighbor.

The seasoned material was of rapid-growth *Pinus Taeda* (trees 1 and 2), which increased in strength from the first formed growth rings towards the periphery of the stem. The outer sapwood in bolts *a* and *d* of tree 1 (fig. 9) had a lower strength than other specimens nearer the pith. The lower strength in the outer sapwood of tree 1 was due to the presence of a large percentage of torquimural tracheids and numerous large rays, particularly fusiform rays (tables III and IV), and not to a lower density (pl. 9, fig. 1, specimen 1aN7). The entire north and east sides of this tree, which were consistently low in strength, were composed of torquimural tracheids. There was a certain amount of this fiber throughout the stem.

Figure 11 shows the compression strength plotted against the specific gravity for the green material. The band[10] of points is thickest through the middle portion and thins out on

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[10] Instead of trying to describe the strength-density relation as a straight-line relationship, the term ''band of points'' is used, which includes the deviation of the individual values from a straight line as shown in figs. 11 and 12.

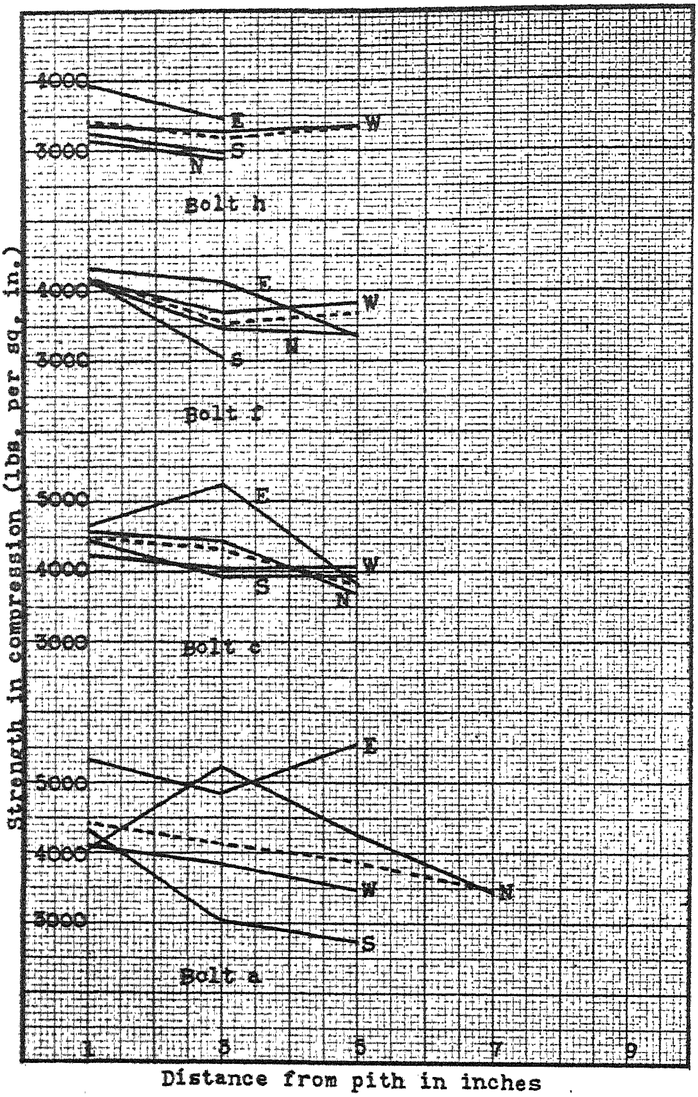

Fig. 7. Tree 4 (*Pinus palustris*, longleaf pine), green. The solid lines represent the compression strength plotted against the distance from the pith for one series of specimens on the various sides indicated; the broken lines, the averages of all tests made at the various distances along the radii.

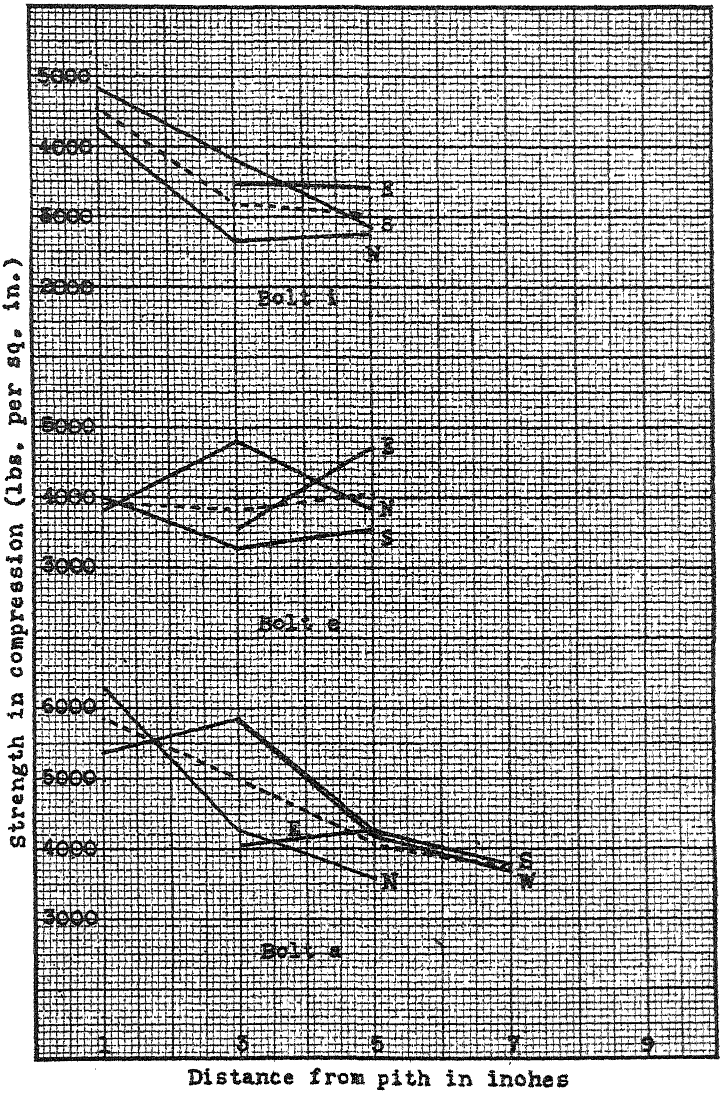

Fig. 8. Tree 6 (*Pinus palustris,* longleaf pine) green. The solid lines represent the compression strength plotted against the distance from the pith; the broken lines, the averages of all tests made in these bolts.

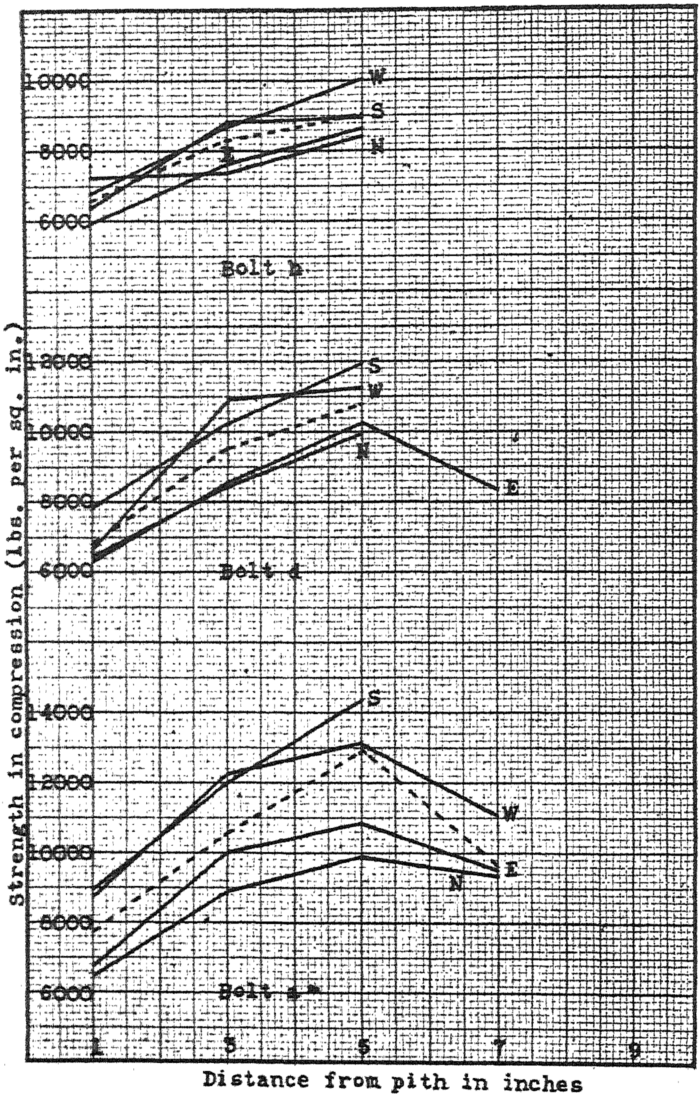

Fig. 9. Tree 1 (*Pinus Taeda,* loblolly pine), seasoned. The solid lines represent the compression strength plotted against the distance from the pith for a single series of tests; the broken lines, the averages of all tests made on each side.

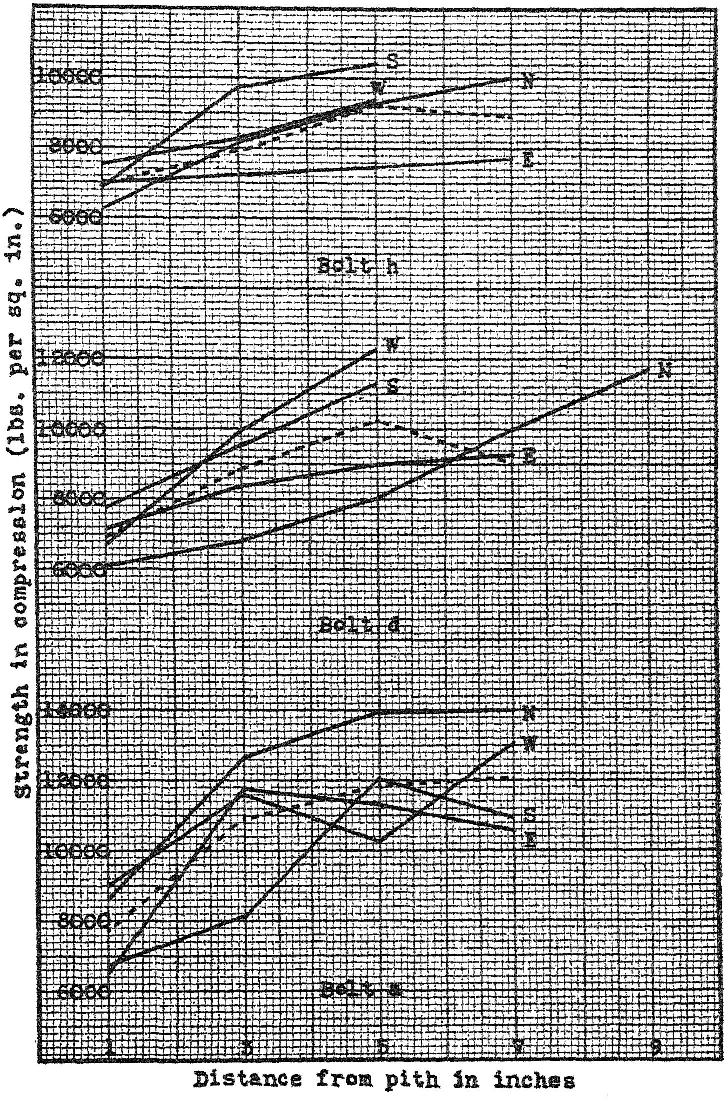

Fig. 10. Tree 2 (*Pinus Taeda*, loblolly pine), seasoned. The solid lines represent a single series of tests from the pith to the periphery of the stem on the four sides; the broken lines, the averages of all the tests made.

either side. The upper edge of the band composed of the strongest specimens per unit weight tends to form a straight line which is essentially parallel with the lower limit composed of the weakest specimens per unit weight and with the mean of all the points. In comparing the individual tests of *Pinus Taeda* and *Pinus palustris*, the former was the stronger for the lower range of specific gravity whereas for the higher range the latter was superior. *Pinus Taeda* seldom surpassed 4,000 pounds per square inch in strength, whereas the greater percentage of *Pinus palustris* was above 3,500 pounds. *Pinus echinata* covered practically the entire range of strength and density and was found in both the top and bottom edges of the band of points.

Table IX gives the strongest specimens for a given specific gravity, those found in the upper limits of the band in fig. 11, and the weakest specimens found on the opposite side of the same band. The stronger specimens had an average of 1,000 pounds greater strength than the weaker specimens, but at the same time 0.057 lower average density. The percentage of summer wood and the area taken up by resin ducts and wood rays were greatest in the weak specimens but the rings per inch and tracheid length were practically the same. In addition, a large number of the weaker specimens contained varying amounts of torquimural tracheids and all of them contained crooked or otherwise inferior tracheids (pl. 10, figs. 4 and 5), whereas the stronger specimens were made up of straight uniform concentrimural tracheids.

The seasoned material with a moisture content of from 7 to 8 per cent was about 2.6 times stronger than similar material in the green condition. Figure 12 shows the strength of the seasoned material plotted against the specific gravity. The same type of band was formed as in the green material. Table X shows the strongest and weakest specimens as found on the opposite sides of this band. The same conditions in the cells in the strong and weak material were found here as in the green material except that the torquimural cells were more pronounced, and the area taken up by resin ducts and wood rays was much higher in the weak specimens. The wood rays were slightly larger and more numerous in areas containing a large percentage of torquimural tracheids, particularly the fusiform rays which were more effective in causing failures.

The poor differentiation of spring and summer wood in the early growth of a tree, and numerous rings in the later growth, together with the differences in thickness of cell walls in both the spring and summer wood of the different species, caused a difference in the density of the material containing an equal percentage of summer wood. *Pinus palustris* had thicker-

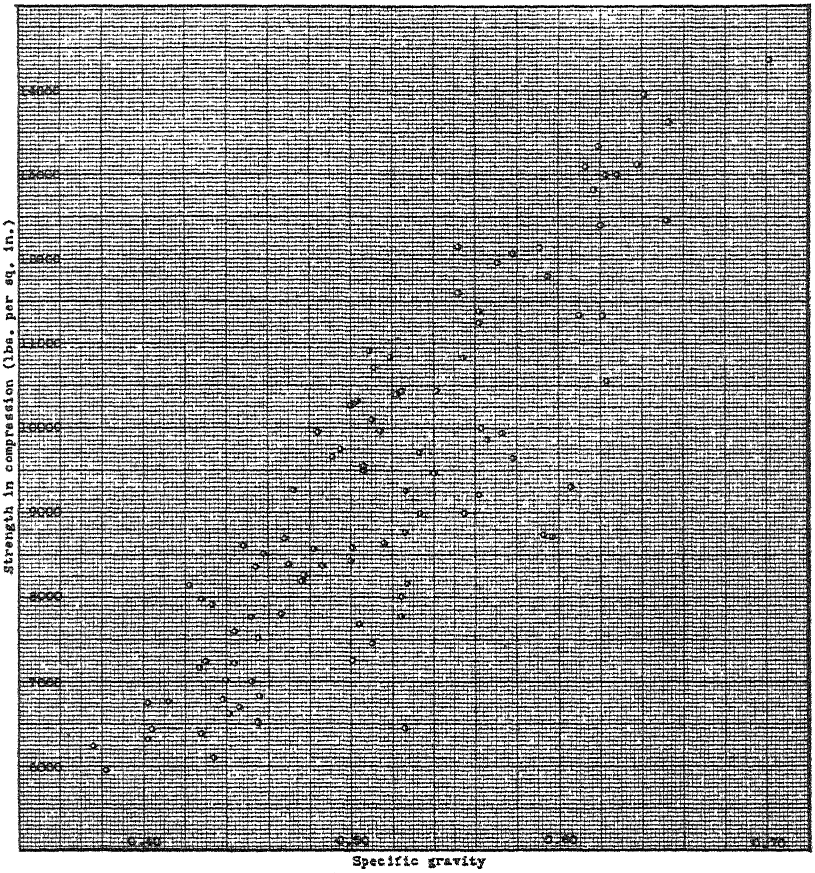

Fig. 12. The compression strength for the seasoned material, trees 1 and 2 (*Pinus Taeda*, loblolly pine), plotted against the specific gravity.

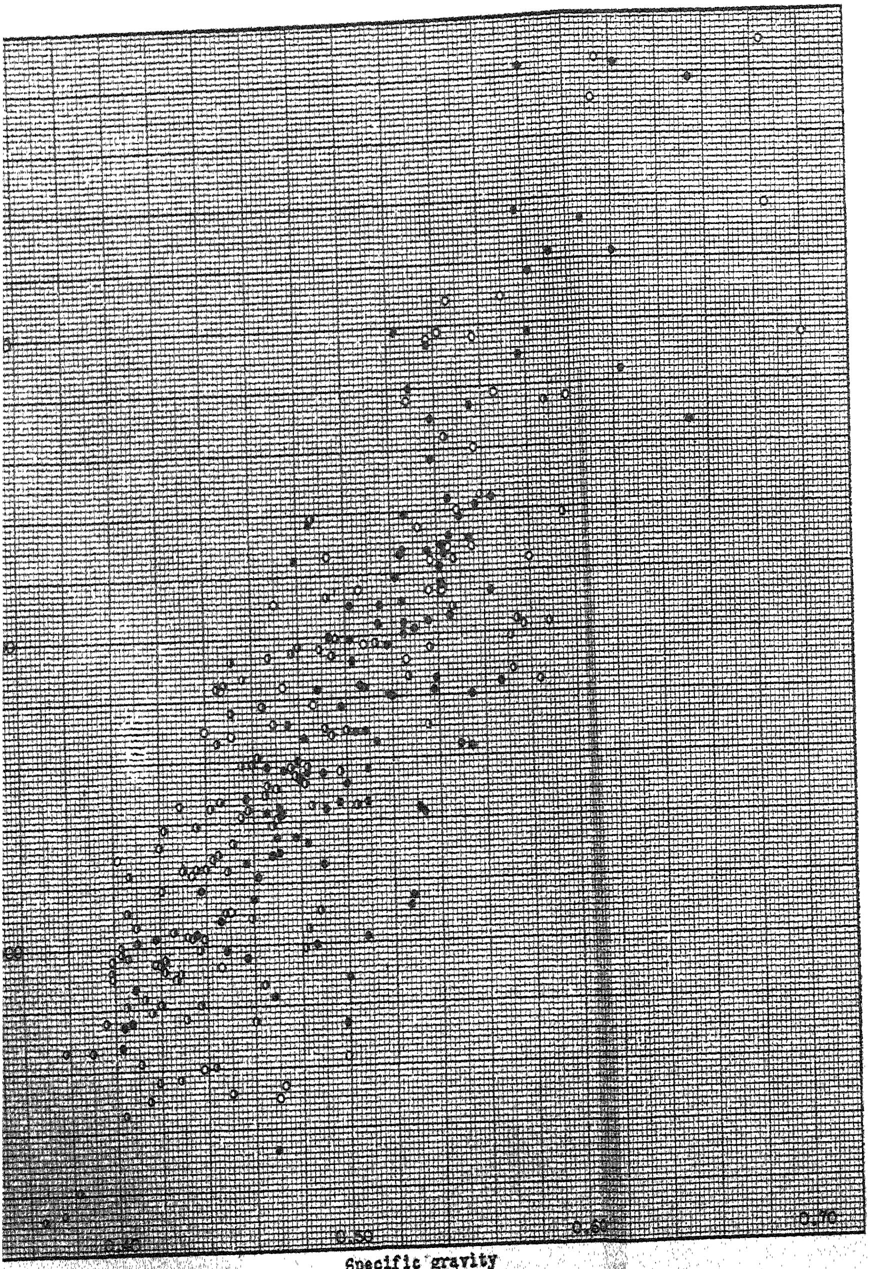

Fig. 11. The compression strength for the green material plotted against the specific gravity. *Pinus Taeda* (lob-

TABLE IX

THE 15 STRONGEST AND THE 15 WEAKEST SPECIMENS PER UNIT WEIGHT TAKEN FROM FIG. 11—GREEN MATERIAL

| Tree and specimen No. | Compression strength in lbs./sq. in. | Specific gravity | Percentage of resin | Percentage of moisture | Percentage of summer wood | Rings per in. | Tracheid length | Total area taken up by resin ducts and wood rays |
|---|---|---|---|---|---|---|---|---|
| Strongest specimens per unit weight | | | | | | | | |
| 6aS3 | 5830 | 0.580 | 8.2 | 35 | 43 | 39 | 4.7 | 7.88 |
| 6aN1 | 6300 | 0.620 | 8.6 | 25 | 47 | 42 | 4.4 | 7.59 |
| 6aN3 | 4250 | 0.479 | 4.1 | 91 | 45 | 12 | 4.7 | 7.24 |
| 3hS2 | 3290 | 0.402 | 3.9 | 32 | 14 | 11 | 3.8 | 7.74 |
| 3hN2 | 3830 | 0.447 | 3.9 | 29 | 23 | 11 | 3.8 | 7.07 |
| 3hE3 | 4110 | 0.470 | 1.0 | 31 | 41 | 12 | 4.8 | 7.18 |
| 3gN2 | 3700 | 0.440 | 2.2 | 29 | 38 | 10 | 3.9 | 7.07 |
| 3bS2 | 5080 | 0.546 | 2.0 | 32 | 55 | 19 | 4.0 | 7.36 |
| 3bS4 | 4950 | 0.537 | 2.3 | 54 | 51 | 19 | 4.2 | 7.36 |
| 4dN4 | 4370 | 0.485 | 4.3 | 46 | 43 | 20 | 5.0 | 7.71 |
| 4bN3 | 4940 | 0.537 | 4.6 | 39 | 40 | 23 | 4.7 | 7.99 |
| 5iN10–1 | 3930 | 0.451 | 1.0 | 34 | 43 | 8 | 5.1 | 9.59 |
| 5iN3–4 | 3840 | 0.445 | 1.8 | 35 | 38 | 10 | 5.0 | 9.41 |
| 5iN3–3 | 3850 | 0.448 | 4.0 | 32 | 42 | 7 | 4.4 | 9.20 |
| 5iE9 | 4390 | 0.486 | 1.5 | 31 | 45 | 7 | 4.8 | 9.06 |
| Ave. | 4440 | 0.491 | 3.56 | 39 | 41 | 16.6 | 4.5 | 8.62 |
| Weakest specimens per unit weight | | | | | | | | |
| 3gS6 | 2630 | 0.499 | 2.9 | 109 | 46 | 20 | 5.2 | 7.37 |
| 3gS4 | 2500 | 0.470 | 2.9 | 47 | 33 | 18 | 4.8 | 8.11 |
| 3gS4–1 | 2540 | 0.472 | 3.4 | | 32 | 12 | 4.9 | 7.89 |
| 3aE7 | 4950 | 0.700 | 2.1 | 30 | 61 | 9 | 4.3 | 8.62 |
| 4bN6 | 2330 | 0.469 | 3.5 | 115 | 41 | 26 | 5.0 | 8.98 |
| 4gW6 | 3120 | 0.527 | 3.1 | 109 | 40 | 21 | 5.1 | 8.69 |
| 4eN2 | 4670 | 0.652 | 4.5 | 22 | 40 | 33 | 4.0 | 8.81 |
| 4aS3 | 3020 | 0.508 | 2.3 | 124 | 45 | 19 | 4.7 | 8.65 |
| 4aN7 | 3420 | 0.531 | 1.9 | 110 | 45 | 18 | 5.0 | 9.34 |
| 4hN1 | 3150 | 0.528 | 23.5 | 23 | 41 | 22 | 4.0 | 8.95 |
| 4hN4 | 3630 | 0.554 | 7.4 | 69 | 57 | 22 | 5.2 | 8.51 |
| 5bE5 | 3840 | 0.584 | 1.7 | 35 | 57 | 5 | 3.7 | 9.26 |
| 5bN3–3 | 4030 | 0.588 | 1.9 | 34 | 56 | 5 | 4.6 | 10.63 |
| 5bS5 | 3880 | 0.572 | 1.9 | 32 | 63 | 5 | 4.0 | 9.57 |
| 5bN5 | 4020 | 0.577 | 2.5 | 36 | 62 | 5 | 3.7 | 9.53 |
| Ave. | 3448 | 0.548 | 4.37 | 59 | 48 | 16 | 4.5 | 8.86 |

walled cells with smaller lumina than either *Pinus echinata* or *Pinus Taeda*. It is indicated from fig. 13 that for a given specific gravity *Pinus echinata* must contain about 10 per cent and

TABLE X

THE 10 STRONGEST AND THE 10 WEAKEST SPECIMENS PER UNIT WEIGHT TAKEN FROM FIG. 12—SEASONED MATERIAL

| Tree and specimen No. | Compression strength in lbs./sq. in. | Specific gravity | Percentage of resin | Percentage of moisture | Percentage of summer wood | Rings per in. | Tracheid length | Total area taken up by resin ducts and wood rays |
|---|---|---|---|---|---|---|---|---|
| Strongest specimens per unit weight | | | | | | | | |
| 2dS6 | 12150 | 0.552 | 0.9 | 6.9 | 52 | 6 | 4.9 | 11.17 |
| 1dW3 | 10920 | 0.509 | 1.1 | 6.9 | 45 | 10 | 4.3 | 8.74 |
| 2hN8 | 10720 | 0.511 | 0.9 | 6.6 | 49 | 7.5 | 5.1 | 10.59 |
| 1dE6 | 9940 | 0.484 | 1.0 | 7.3 | 47 | 7.5 | 4.8 | 9.49 |
| 2hN3 | 8140 | 0.422 | 3.9 | 8.0 | 26 | 2 | 4.0 | 9.73 |
| 1dE5 | 10260 | 0.500 | 1.4 | 7.3 | 48 | 7 | 4.8 | 9.94 |
| 2dS4 | 10830 | 0.519 | 0.5 | 6.2 | 52 | 5 | 3.7 | 10.97 |
| 1dE4 | 10320 | 0.503 | 1.1 | 7.3 | 43 | 10 | 4.3 | 9.03 |
| 1dS3 | 10280 | 0.501 | 1.2 | 6.6 | 43 | 6 | 4.0 | 9.16 |
| 1hE5 | 8610 | 0.448 | 2.2 | 7.9 | 40 | 9 | 4.9 | 9.21 |
| Ave. | 10217 | 0.495 | 1.4 | 7.0 | 44.5 | 7 | 4.48 | 9.90 |
| Weakest specimens per unit weight | | | | | | | | |
| 1aN7 | 9300 | 0.606 | 0.9 | 7.1 | 70 | 6.5 | 4.6 | 11.87 |
| 1aN8 | 8720 | 0.597 | 2.3 | 7.2 | 65 | 8 | 4.6 | 12.18 |
| 1aS2 | 8730 | 0.593 | 3.7 | 6.0 | 38 | 4 | 2.3 | 10.43 |
| 1aN1 | 6430 | 0.526 | 5.4 | 6.5 | 38 | 3 | 2.9 | 10.30 |
| 2aE7 | 10560 | 0.623 | 1.9 | 7.2 | 65 | 5 | 4.5 | 11.72 |
| 2hE6 | 7780 | 0.524 | 2.3 | 7.6 | 56 | 3 | 4.8 | 11.81 |
| 2hE8 | 7250 | 0.501 | 2.2 | 7.8 | 40 | 7 | 5.1 | 11.34 |
| 2hE5 | 7450 | 0.510 | 1.1 | 7.7 | 32 | 3 | 4.3 | 11.35 |
| 2dN5 | 8010 | 0.524 | 1.8 | 6.2 | 45 | 5 | 4.5 | 10.21 |
| 2aE8 | 9650 | 0.578 | 1.2 | 7.6 | 65 | 6 | 4.9 | 11.40 |
| Ave. | 8388 | 0.558 | 2.28 | 7.0 | 51 | 5 | 4.2 | 11.26 |

*Pinus Taeda* 20 per cent more summer wood than *Pinus palustris*. This is further amplified by fig. 14, which shows the strength plotted against the percentage of summer wood. For the most part, each species occupied a different region of the graph, *Pinus Taeda* being weakest, *Pinus palustris* strongest, and *Pinus echinata* intermediate for a given percentage of summer wood. The overlapping of the species was greatly influenced by the variations in strength in a given species due to inferior fibers as described for the material represented in figs. 11 and 12. When the strength of a single species was plotted against the percentage of summer wood, however, there was less spread of points and a band similar to the specific gravity-strength relations was obtained (fig. 15). Since the specific gravity (when corrected for resin content) is a more accurate measure of the mass represented, there was less spread in the points when the specific gravity was plotted against the strength (compare figs. 12 and 15). Essentially the same specimens were found in the upper and lower limits of the bands in these two figures.

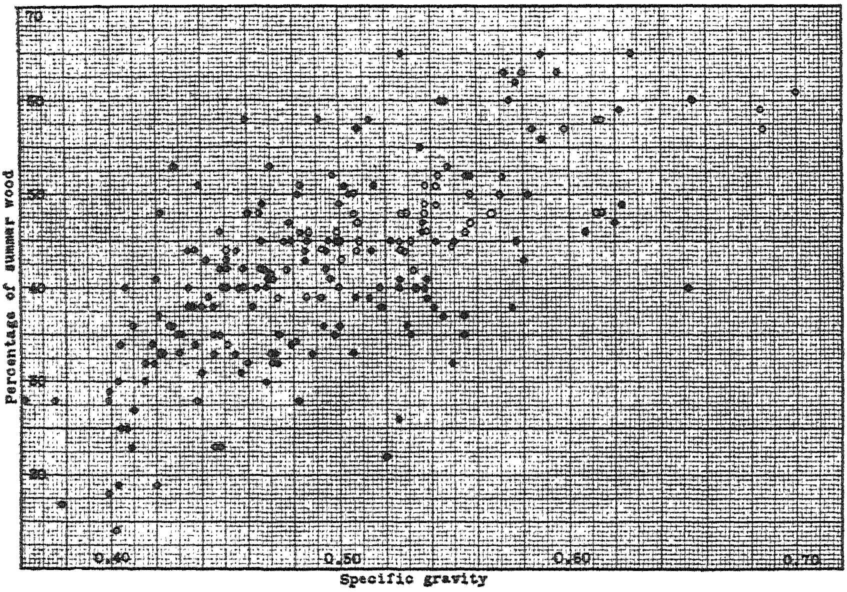

Fig. 13. The percentage of summer wood plotted against the specific gravity. *Pinus Taeda* (loblolly pine), black-and-white circle; *Pinus echinata* (shortleaf pine), white circle; *Pinus palustris* (longleaf pine), black circle.

## DISCUSSION

The specific gravity of clear specimens of southern yellow pine wood is not an accurate measure of its strength, and the percentage of summer wood, without regard for the density of the different species, shows even greater variations under present specifications. Resins increase the specific gravity,

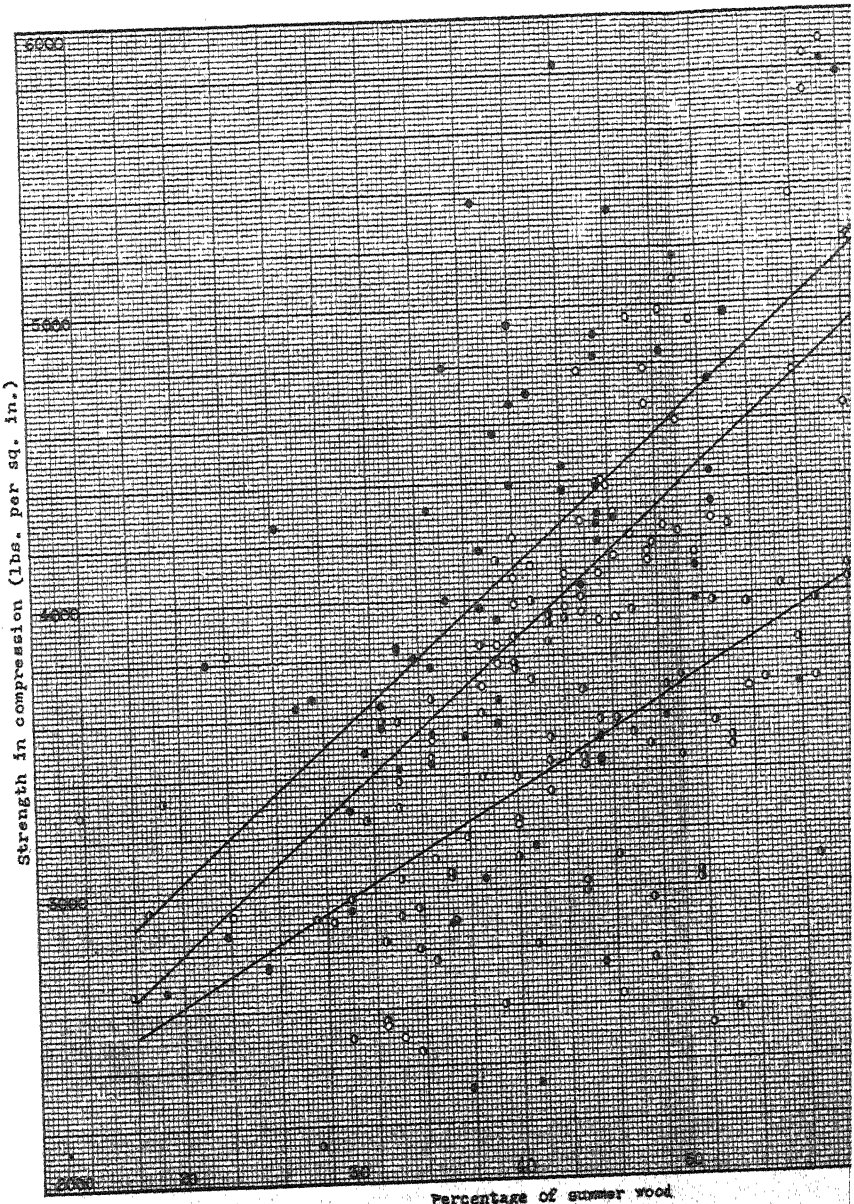

Fig. 14. Trees 5 and 7 (black-and-white circle, *Pinus Taeda*), tree 3 (white circle, *Pinus echina*
(black circle, *Pinus palustris*), green. The compression strength plotted against the percentage
The lines represent the averages of the various species as indicated. The wide spread of points
tributed to the differences in density of the summer wood in the three species as shown in fig. 13.

with little or no effect upon the strength. Although the wider variations were eliminated by correcting the specific gravity for benzol-soluble compounds, there were still variations of from 1,500 to 2,000 pounds per square inch for practically the entire range of specific gravity in the green material. In spite of these variations the strength of the best material varied directly with the first power of the density, and the average strength of the different species agreed very well with the averages reported by Newlin and Wilson ('17) for the same

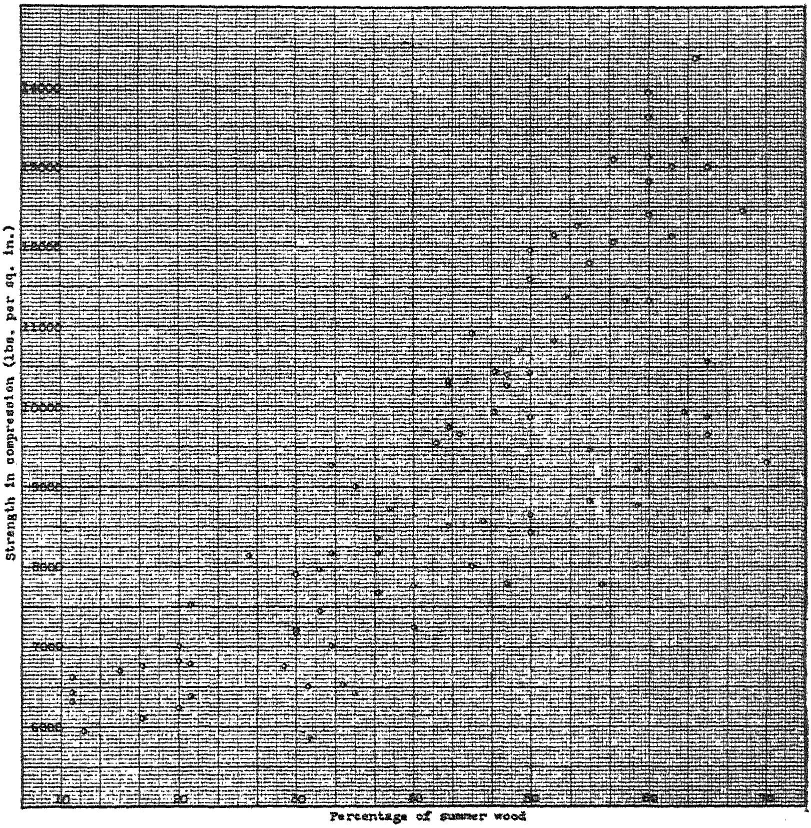

Fig. 15. Trees 1 and 2 (*Pinus Taeda*), seasoned. The compression strength plotted against the percentage of summer wood. Note the close agreement of this figure with that of fig. 12, which represents the compression strength plotted against the specific gravity for the same material.

species, with the exception of tree 3, *Pinus echinata*, which was unusually strong for its species. There was an increase of about 1,300 pounds per square inch for an increase of 0.1 in specific gravity in the green material and about 3,000 pounds in the dry material if only the most perfect specimens were considered. When the increase in strength for the changes of moisture was accounted for, both the green and seasoned material showed essentially the same relations of density and strength.

Since the variable due to moisture content was eliminated by using only green material (that with a moisture content above the fiber-saturation point) and specimens of a similar moisture, and since the absolute density of the wood substance was constant, the variations in strength were attributed to the differences in structure. The anatomical structure of the southern yellow pines is simple and has been described by Mohr and Roth ('97) and others. The woody cylinder or xylem is composed primarily of tracheids with occasional groups of wood parenchyma. An anastomosing system of resin canals and the wood rays make up the remainder of the structure.

In order to make any correlation between the strength and the structure, it was necessary to evaluate the strength on a unit-weight basis known as the specific gravity. The short-fibered material in the first few growth rings was weak, being less than half as strong in certain cases as the longer-fibered material farther out in the tree, but it was also much lighter. The very first rings, however, were not so strong in proportion to their density as the best material containing the longer tracheids. On the other hand, they were not so weak in proportion as the poorest material, which also contained long tracheids. The weakness of this short-fibered material was apparently due to the large number of resin canals and wood rays which interrupted the unity of the material. In very slow-growth trees this area may be neglected but in rapid-growth material there may be a difference of 50 to 100 per cent in strength along a radius of from 6 to 8 inches (table VIII, compare specimen 1dS2 with 1dS6 and 2aN2 with 2aN5).

As the tracheids increased in length the density also increased, but the latter reached a maximum between the ages of 40 and 100 years (also Mohr and Roth, '97), after which it declined more or less rapidly, whereas the tracheid length sometimes fluctuated although with little regular reduction in length. The maximum strength was found to be in this high density material in the intermediate zone, but the strength was often much lower than was indicated by the density. It was for the most part this high-density material that showed the greatest fluctuation in strength per unit weight.

Comparing the extremes in strength per unit weight, there was little difference in the length of the tracheids and rings per inch in the strongest and weakest specimens of the green material, but there were differences in the percentage of area taken up by resin ducts and wood rays and particularly in the contour of the cells and the structure of the cell walls. The percentage of area taken up by the wood rays and resin ducts was noticeably greater in the weak specimens of the seasoned material, but it is evident that these factors (fiber length, resin canals, and wood rays) were not entirely responsible for the wider variations in strength although it was indicated that they contributed to it. The fact that the tracheids buckled away from the rays (pl. 13, figs. 3 and 4) indicated that an excess of rays would be weakening. Furthermore, areas containing a high percentage of torquimural tracheids had a greater percentage of rays than the other material.

There was no direct correlation between the number of rings and the strongest or weakest specimens per unit weight, but the greatest strength for a given tree was usually found in the intermediate growth, while low density and low strength were associated with extremely rapid or slow growth. The weaker specimens per unit weight had a much higher percentage of summer wood than the stronger ones regardless of species, but in the material containing straight uniform tracheids with concentric laminae (concentrimural tracheids) the strength increased with the summer wood within a given species. In general, however, for a given specific gravity, *Pinus echinata* contained 10 per cent and *Pinus Taeda* 20 per cent more summer wood than *Pinus palustris,* and similarly for a given strength there was a greater percentage of summer wood in *Pinus Taeda* and *Pinus echinata* than in *Pinus palustris.* From this it is concluded that for the strongest material per unit weight one must choose medium to low density *Pinus Taeda* and medium to high density *Pinus palustris.* This is borne out by fig. 11, which shows that for the lower density material *Pinus Taeda* is the strongest, whereas for the high density material, *Pinus palustris* and *Pinus echinata* are superior. *Pinus echinata* was not sufficiently well represented here to justify any definite statement as to how it would fit into this relationship.

Since the poorer material was not confined to the very dense or very light wood and since the greater variations in strength were not entirely due to the length of the tracheids nor the wood rays and resin canals, the cause must be sought in the general contour of the cells and the structure of the cell walls. Weakness was associated with torquimural, crooked, and otherwise deformed tracheids, although the walls of the latter were often made up of the usual concentric laminae. The crooked fibers tended to buckle more readily than the straight ones, which caused the material to be considerably weaker than was indicated by its density.

Sonntag ('04) found that the tensile strength of ordinary wood was from 25 to 50 per cent greater than that of compression wood (torquimural cells). He also stated that the compression side of the tree had a greater resistance to compression than the tension side due to the thicker walls, which gave a greater resistance to bending in that direction. He did not take into account the great differences in density, however, which more than offset the increase in strength or stiffness. Jaccard ('28) observed that compression wood contained a higher percentage of lignin than normal wood, as did Dadswell and Hawley ('29) for compression wood of Sitka spruce. Koehler ('33) reported that compression wood in the green condition was low in stiffness and on a unit-weight basis was inferior in all strength qualities. When seasoned the differences were much greater, and the compression wood was very brash in tension.

The torquimural tracheids, with an entirely different wall structure from the concentrimural cells, were brash and had from 1,500 to 2,000 pounds less strength per unit weight in the green condition and from 2,000 to 3,500 pounds less in the seasoned condition than the material made up of straight cells. The increase of strength with dryness was not so great in the specimens containing large quantities of torquimural cells, due primarily to the checking of the individual cell walls and to the internal stresses caused by unequal shrinkage. The middle lamella had the same concentric arrangement as the concentrimural cells and in most cases the latter were interspersed with the torquimural tracheids. This condition, together with the great differences in the pitch of the spiral of the laminae (and micells which are contained in the laminae) in adjacent torquimural cells, was responsible for these internal stresses. The low strength of the torquimural tracheids in the green condition was caused by two factors: (1) the structure of the cell walls, and (2) the poor union between the cells, due to the rupture of the middle lamellae forming interstitial spaces.

The great differences in strength per unit weight of green southern yellow pine may be largely attributed to the variations in the straightness of the tracheids, disruption of the middle lamellae forming interstitial spaces, the structure of the cell walls, and, to a certain extent, to the variations in resin ducts and wood rays (particularly fusiform rays). It must be borne in mind, however, that the effects of these factors were accumulative, that no single one of them alone, with the possible exception of the structure of the cell wall, was responsible for the wider variations in strength.

Due to the fact that one or more of the above factors was present and effective to a certain extent in any given sample of wood, it is evident that the density plotted against the strength is not a straight-line relation but a band relation, of which the more perfect specimens will be found in the upper portion and the spread depends upon the diversity of the material.

Although variations of from 50 to 100 per cent in strength of small clear specimens in southern yellow pine timber taken from the same tree and similar but smaller variations in strength of specimens of the same density may be expected, this need not be an unsurmountable barrier to the grading and uses of this material for special designs. The knowledge of the variations in density and strength in the cross-section in relation to the age and growth rate of the tree and at the different heights in the tree will make it possible to cut timbers of a structural size without serious differences in strength. The knowledge of the differences in specific gravity for a given percentage of summer wood in the various species will make it possible to evaluate the strength more correctly on the basis of percentage of summer wood. The serious defects in the form of crooked fibers and torquimural tracheids are visible in dressed materials and may be eliminated in pieces of small dimensions. A more complete knowledge of the extent and distribution of these major defects in the virgin and second-growth timber of a given species and in different species of wood used for structural timbers will make it possible to modify the grading rules to take care of these variabilities.

The bending strength and elastic properties of this material, together with a more complete treatment of the compression strength as related to engineering practice, will be given in a future paper.

## Summary

1. Compression tests parallel to the grain, together with a study of the physical properties and microscopic structural features, were made on small specimens of clear wood taken from seven southern yellow pine trees cut in Walthall County, Mississippi. Four of these trees were *Pinus Taeda,* one was *Pinus echinata,* and two were *Pinus palustris.*

2. The fiber-saturation point as measured by the electro-conductivity method was 22.5 ± 1 per cent.

3. The absolute density of the wood substance was 1.52 as compared with water at 4° C.

4. The percentage of benzol-soluble materials designated as resins varied from 0.4 to 21 per cent in *Pinus Taeda,* with an average of 2.3 per cent, from 0.9 to 6.4 per cent in *Pinus echi-*

*nata,* with an average of 2.5 per cent, and from 0.9 to 29.1 per cent in *Pinus palustris,* with an average of 5.6 per cent.

5. The rate of growth varied from 1¾ to 25 rings per inch in *Pinus Taeda,* from 5 to 21 rings in *Pinus echinata,* and from 9 to 55 rings per inch in *Pinus palustris.* The first-formed rings of the *Pinus Taeda* trees were very broad, the growth rate decreasing with an increase in the age of the tree, whereas in the *Pinus echinata* and *Pinus palustris* trees the first 2 to 4 inches from the pith were of very slow growth, the growth rate increasing with the age of the trees.

6. The percentage of summer wood, and thus the density, decreased from the region of the base of the tree towards the crown. In general, the density increased from the first growth ring to a maximum in the region of the 100th ring and declined from this point towards the periphery of the stem.

7. For a given specific gravity, *Pinus echinata* contained about 10 per cent, and *Pinus Taeda* 20 per cent, more summer wood than *Pinus palustris.* The differences in density were due to the variations in thickness of the cell walls.

8. The percentage of area taken up by resin ducts was greatest in *Pinus Taeda* and least in *Pinus echinata.*

9. The wood rays decreased in number and increased in size from the pith to the periphery of the stem in all three species. They occupied slightly more area at the base of the tree, decreased somewhat at the higher levels, and again increased to a second maximum at the top. They were largest in the rapid-growth *Pinus Taeda* and smallest in *Pinus echinata.*

10. The tracheid length increased rapidly through the first 10 growth rings and more slowly through the remaining rings. Slight fluctuations in length were observed in the outer portions of the older trees. The tracheid length increased from the stump level towards the top of the tree, at least for the first few feet.

11. Torquimural tracheids are defined as cells with or without interstitial spaces, moderately to very dense, the secondary thickening of the individual cell wall being sharply differentiated from the primary wall by its radial bands or laminae which lie in a spiral around the cell. Torquimural tracheids

were not confined to the leaning side of the tree, but they occurred also on opposite sides of the same cross-section.

12. Failure in compression was accompanied by buckling of the tracheids in the direction of a tangent to the annual rings. The buckling cells separated from each other at the interfaces of the middle lamella and the secondary thickenings. In the concentrimural cells, buckling was accompanied by a folding of the wall on the inner side of the curve, whereas in the torquimural cells, when buckling occurred, it was usually accompanied by a shredding of the laminae, although the tracheids often settled by folding upon themselves or broke off short.

13. The compression strength was roughly proportional to the specific gravity, but there were variations of from 40 to 70 per cent in strength (based upon the minimum strength) for a given specific gravity. Due to the numerous factors affecting strength, the strength-density relationship is better expressed by a band than a straight line. The strength decreased from a maximum in the lower 12 to 16 feet of the tree towards the crown regardless of species. It increased from the region of the pith towards the periphery of the stem. The strength reached a maximum in the outer sapwood of the younger *Pinus Taeda* trees, and from 7 to 11 inches from the pith in the older *Pinus Taeda* tree after which it declined rapidly to a minimum in the outer sapwood, whereas it decreased from the first specimens around the pith towards the periphery of the stem in the *Pinus echinata* and *Pinus palustris* trees.

14. For the low-density material, *Pinus Taeda* had a greater strength per unit weight, whereas for the high-density material *Pinus palustris* and *Pinus echinata* were superior.

15. The strongest wood per unit weight contained straight concentrimural tracheids with few interstitial spaces, whereas wood which was very weak in relation to its density was associated with crooked and torquimural tracheids. The accumulative effects of numerous wood rays and resin ducts also contributed to the weakness of the material.

16. Since the material containing extremely crooked fiber and the more pronounced torquimural tracheids can be dif-

ferentiated in the dressed condition from the better grade of lumber, the above data will aid the man of industry in selecting timbers for special designs. More data of this type will facilitate the formulation of grading rules and make it possible for lumber companies to standardize their products.

The writer wishes to express his gratitude to the officials of the American Creosoting Co., who have made this investigation possible by establishing a research fellowship in the graduate laboratory of the Henry Shaw School of Botany of Washington University and furnished the material for the experiments, and to Dr. Hermann von Schrenk, Pathologist to the Missouri Botanical Garden, for his suggestions and criticisms during the progress of this work and the preparation of the manuscript. The writer is also indebted to Dr. E. S. Reynolds, Physiologist to the Henry Shaw School of Botany, for his suggestions in carrying out the microscopic studies, to Prof. A. W. Brust, of the civil engineering department of Washington University, for help in interpretating the strength data, and to Dr. George T. Moore, Director of the Missouri Botanical Garden, for courtesy extended him in the use of the Garden library. Valuable assistance was rendered by research fellows, Mr. Charles O. Quade and Mr. Chester Abbey (American Creosoting Co. Fellows), in making tests and calculations.

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## Explanation of Plate

### PLATE 9

Three test specimens from each of the seven trees showing some of the variations in growth rate and percentage of summer wood.

Fig. 1. From tree 1 (*Pinus Taeda*, loblolly pine), showing the extreme range in percentage of summer wood. Specimen 1aN7 at the extreme left is composed almost entirely of torquimural tracheids.

Fig. 2. From tree 2 (*Pinus Taeda*, loblolly pine), showing the great variation in growth rate and the poor differentiation of spring and summer wood in specimen 2hS1 at the extreme right.

Fig. 3. From tree 5 (*Pinus Taeda*, loblolly pine), showing the differences in growth rate and percentage of summer wood in the immediate vicinity of the pith (specimen 5iS1), the intermediate zone (5bN12), and in the outer sapwood (5bN3–5). Note the V-shaped markings in 5bN12.

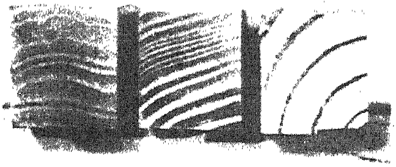
Fig. 4. From tree 7 (*Pinus Taeda*, loblolly pine), showing the major variations in growth rate and percentage of summer wood. Specimen 7gE3 on the extreme right has poor differentiation of spring and summer wood and contains a certain amount of torquimural tracheids.

Fig. 5. From tree 3 (*Pinus echinata*, shortleaf pine), showing the differences in percentage of summer wood and growth rate in the immediate vicinity of the pith at the different heights in the tree as shown in 3aS2 and 3fN1.

Fig. 6. From tree 4 (*Pinus palustris*, longleaf pine), showing variations in growth rate and the irregular rings containing torquimural tracheids as seen in 4cS5.

Fig. 7. From tree 6 (*Pinus palustris*, longleaf pine), showing variations in growth rate and percentage of summer wood. Note the broad rings of summer wood in 6eE5 which are composed largely of torquimural tracheids.

Specimen 1aN7 of fig. 1 is representative of the material found in the weakest specimens per unit weight of the seasoned material, and 4cS5 of fig. 6, of the green material.



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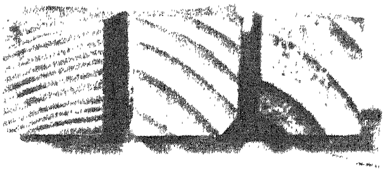

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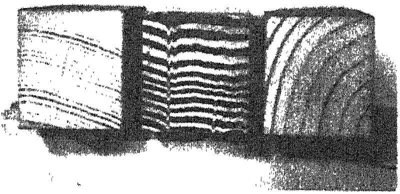

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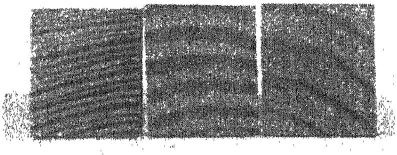

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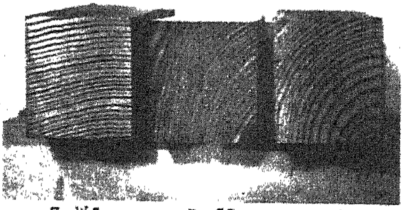

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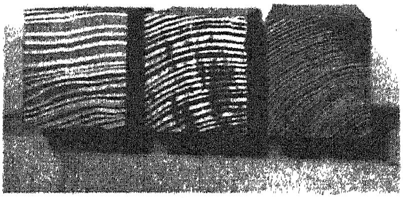

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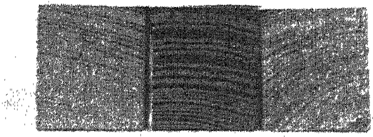

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BERKLEY—SOUTHERN PINE

## Explanation of Plate

### PLATE 10

Fig. 1. A cross-section of the spring-wood portion of an annual ring showing the distribution of the resin ducts. × 13.

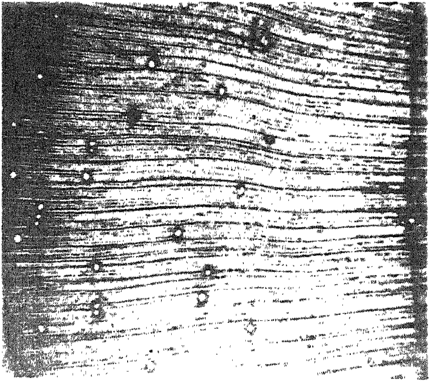
Fig. 2. A row of 4 resin ducts. Note the resin duct on the extreme right branching to form the fifth one. The cells between these resin ducts are all thin-walled parenchyma cells. × 100.

Fig. 3. Concentrimural tracheids showing the curvature and reduction in diameter where they pass the larger wood rays, particularly the fusiform ray. × 100.

Fig. 4. Crooked and deformed tracheids. × 13.

Fig. 5. The crossing of the alternate tiers of tracheids in crooked-fibered material. × 100.

Fig. 6. This figure gives some idea of the extent of the wood parenchyma and the septate tracheids in the region of a series of resin ducts as shown in fig. 2. × 100.



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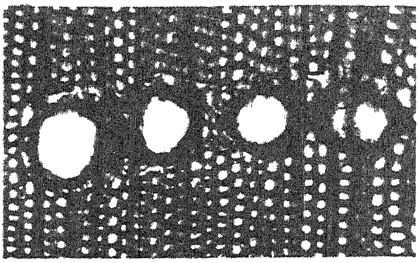

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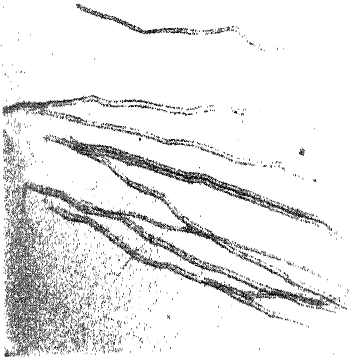

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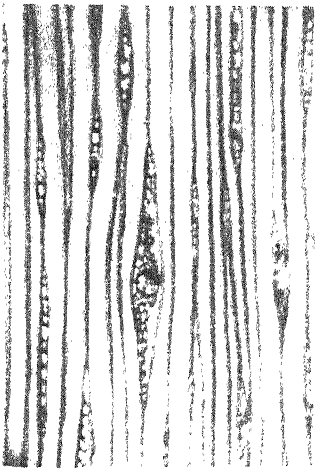

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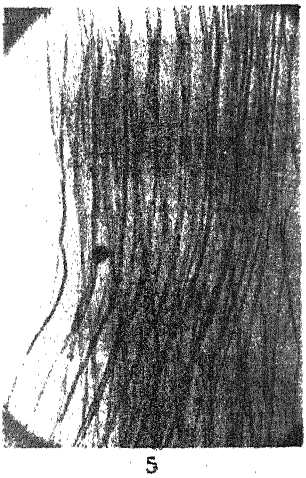

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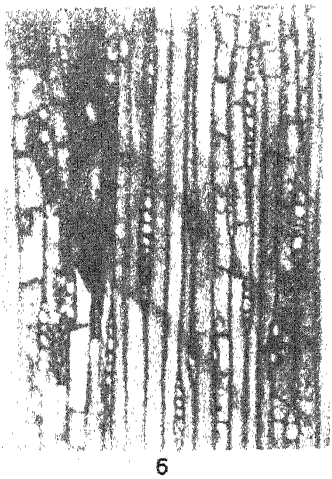

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BERKLEY—SOUTHERN PINE

## EXPLANATION OF PLATE

### PLATE 11

Fig. 1. The diffraction patterns of the concentric laminae in the cell walls as revealed by the Spierer lens. These are typical concentrimural tracheids. × 900.

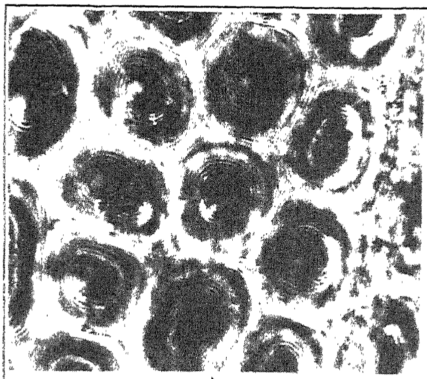
Fig. 2. The concentric laminae of the spring wood cells under direct illumination. This photograph was taken by the use of an ordinary oil-immersion lens. × 900.

Fig. 3. The diffraction patterns of the laminae as shown in the longitudinal section with the Spierer lens. The focus was adjusted on the cell walls and the lumen appears as a dark band between them. × 900.

Fig. 4. A layer of torquimural tracheids (the darkest area) within the summerwood portion of an annual ring. Note the sharp demarcation between the concentrimural cells and the torquimural cells at the inner edge of the latter (to the right) and the gradual disappearance of the torquimural cells on the outer side (to the left) where the two types of cells are intermixed. × 100.

Fig. 5. A longitudinal section of torquimural tracheids showing the spiral checks. Note the striations between the checks. × 450.

Fig. 6. A cross-section of torquimural tracheids showing the interstitial spaces, the sharp demarcation between the primary and secondary walls, and the numerous radial checks in the latter. × 900.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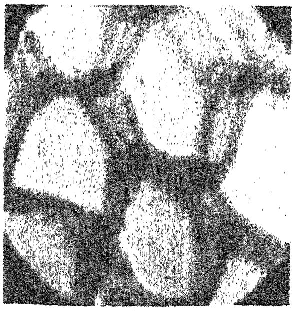
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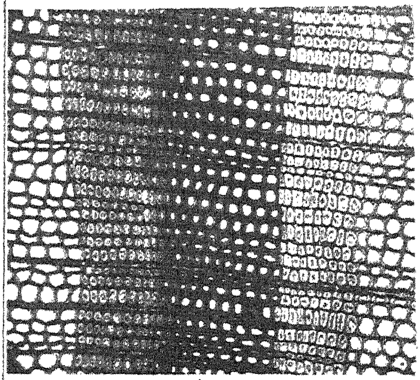
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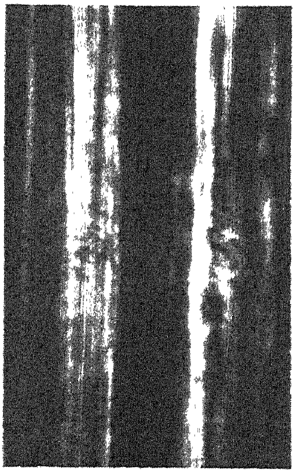
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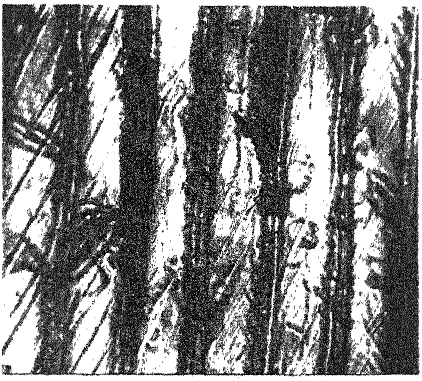
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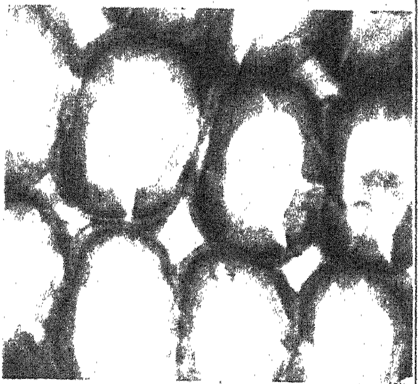
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BERKLEY—SOUTHERN PINE

## EXPLANATION OF PLATE

### PLATE 12

Fig. 1. A cross-section of torquimural tracheids at the right and concentrimural tracheids at the extreme left. The radial striations in the secondary thickening are layers corresponding to the laminae of the concentrimural cells as illustrated in pl. 11, fig. 1. The cells to the extreme left do not have the radial laminae. Photograph taken by the aid of an ordinary oil-immersion lens. × 900.

Fig. 2. The torquimural cells as seen under the Spierer lens. Note the irregularity of the radial laminae. × 900.

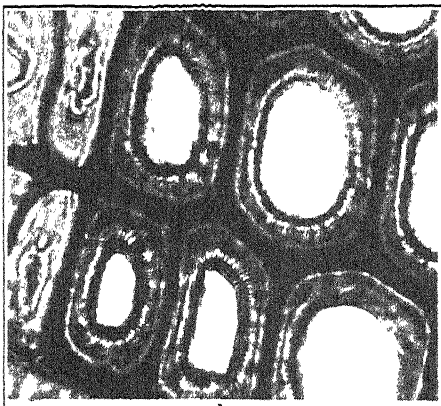
Fig. 3. Torquimural cells as in fig. 2 but showing in addition to the radial laminae of the secondary thickening the concentric laminae of the middle lamella. This area appears somewhat broader than it really is, due to the magnification of the diffraction patterns. × 900.

Fig. 4. The torquimural cells as seen by the use of the cardeoid dark-field condenser. Note the middle lamella which is distinct from the secondary walls which are checked in the radial direction. × 900.

Fig. 5. The same as fig. 4 but at lower magnification which shows more clearly the radial arrangement of the laminae in the secondary thickening. × 450.

Fig. 6. A longitudinal section of torquimural cells as seen under the Spierer lens. Note the spiral arrangement of the striations in the secondary thickening as contrasted with the parallel striations in the region of the middle lamella. This is a tangential section of the cell cutting through the radial laminae of the secondary thickening showing their edge view. Note the area between the middle lamella and the spiral laminae which shows no particular structure. This is due to the angle at which the laminae were cut, showing them on a side view as will be seen if this section is compared with a tangent to the cells shown in figs. 1–5. × 900.

Fig. 7. The spiral striations in the torquimural cells as shown under the dark field. × 900.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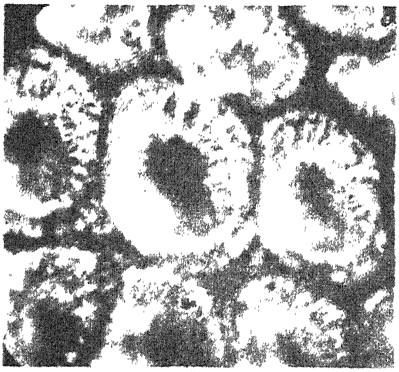
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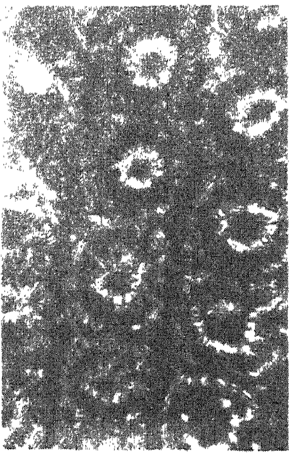
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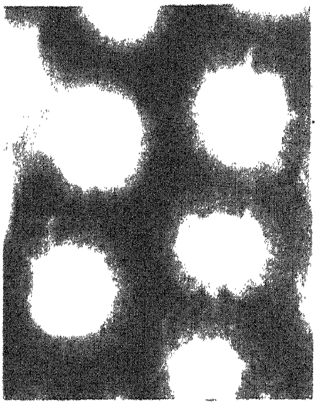
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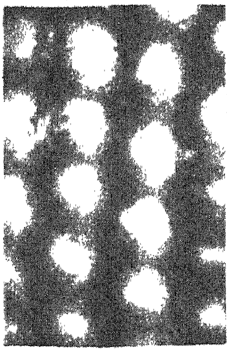
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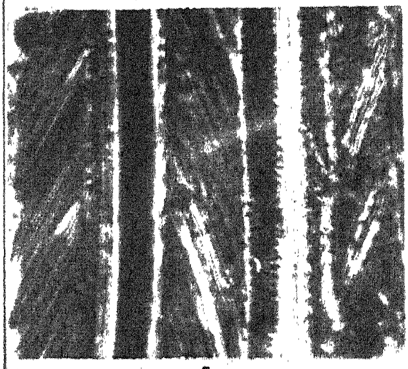
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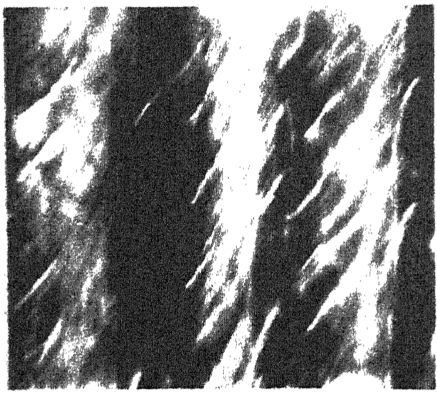
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BERKLEY—SOUTHERN PINE

# EXPLANATION OF PLATE

## PLATE 13

Fig. 1. Typical compression failures. In *a*, two offsets or planes of failure occurred parallel to each other. In *b*, a wedge split resulted where two planes of failure intersected. In *c*, two offsets met near the edge of the specimen. (The fungous growth on *c* occurred after the specimen was tested.)

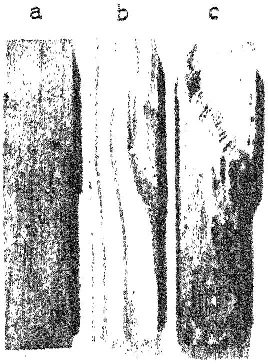
Fig. 2. A cross-section through the zone of failure, showing the tiers of tracheids separated from each other. Note the spring-wood cell walls folded into the lumina of the cells and the fragments of the middle lamella pulled from between. These folded walls represent only the secondary thickening since the middle lamella was still attached to the opposite cells. × 100.

Fig. 3. Tangential section through the region of failure showing buckled tracheids. Note the openings at the rays and the tendency of certain tracheids to buckle in opposite directions at different points due to the curvature of the cells and the direction of the major failure. × 100.

Fig. 4. A region of failure showing the extent of the failure in regions which are not visible to the unaided eye. × 50.

Fig. 5. A short segment of the buckled portion of a cell as seen under the Spierer lens. Note the folding of the inner wall. × 900.

Fig. 6. A brash failure typical of seasoned torquimural cells. Note the cross hatching in the cell walls due to the checks which tend to show through from the opposite walls, thus appearing to cross. × 100.



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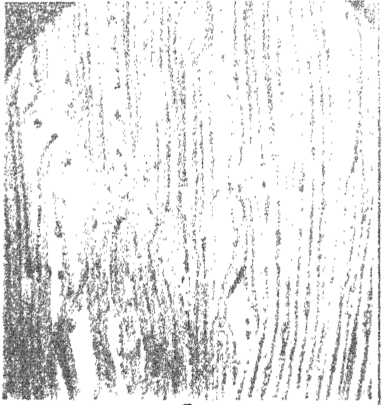

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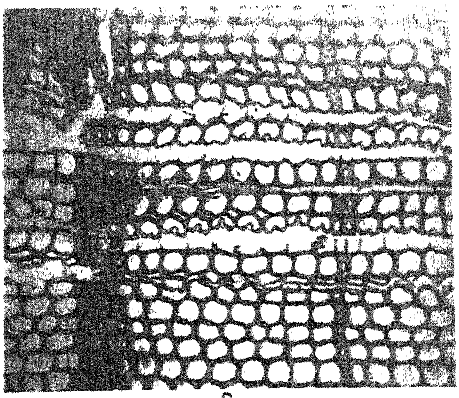

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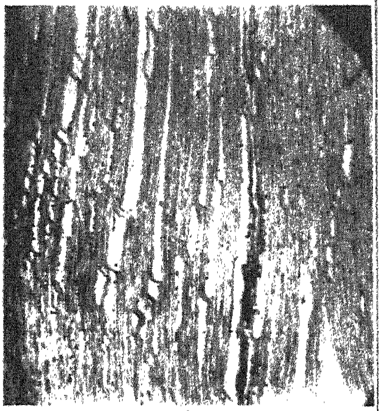

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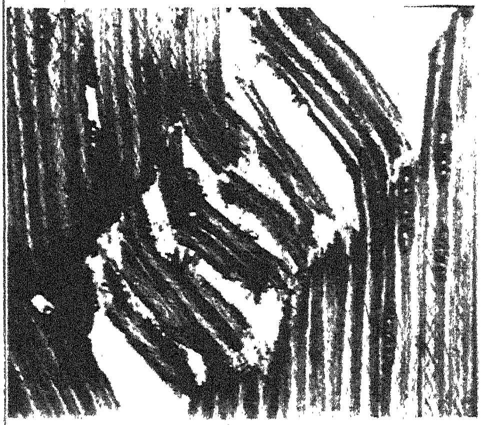

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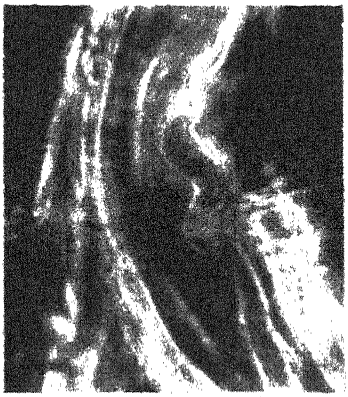

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BERKLEY—SOUTHERN PINE

# PORIA COCOS (SCHW.) WOLF, FOUND ON A RAILROAD TIE IN SERVICE

EARL E. BERKLEY

*Research Fellow in the Henry Shaw School of Botany of Washington University*[1]

The tuckahoe was identified as *Poria Cocos* by Wolf,[2] who was the first to find the mature fructifications associated with the sclerotium. The range of hosts and the synonymy for this organism have recently been summarized by Weber.[3] For the most part it has been found associated with the roots of trees as a parasite. Ravenel,[4] however, found a number of small specimens partially embedded in the decayed wood of an old pine rail, but no rhizomorphs or other direct attachments were observed.

The specimen shown in pl. 14, fig. 1, was found by workmen on the Memphis Terminal of the Missouri Pacific Railroad on a *Taxodium* cross-tie which they were removing from the tracks, and it was given to the writer by Dr. Hermann von Schrenk.[5] The sclerotium was attached to a lower corner of the tie about midway between the tracks and was concealed by cinder ballast. The track at this point was on a fill where it was usually dry. The tie had been in service about eight years and was badly decayed.

The dark brown rind of the sclerotium, which was sharply contrasted with the interior, was corrugated and resembled somewhat the bark of a tree. This rind and a few millimeters of the area beneath it contained fragments of the host tissue,

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[1] A fellowship established by the American Creosoting Co.

[2] Wolf, F. A. The fruiting stage of the tuckahoe, *Pachyma Cocos*. Elisha Mitchell Scientif. Soc., Jour. **38**: 127–137. 1922.

[3] Weber, G. F. The occurrence of tuckahoes and *Poria Cocos* in Florida. Mycologia **21**: 113–130. 1929.

[4] Ravenel, H. W. Note on the tuckahoe. Bull. Torr. Bot. Club **9**: 140. 1882.

[5] The field notes were furnished by Mr. K. G. Williams, Division Engineer at Memphis, Tenn. (letter of G. R. Westcott, dated Nov. 23, 1933, in files of Dr. Hermann von Schrenk, file 16214).

Issued June 5, 1934.

and the wood to which the tuckahoe was attached was thoroughly permeated by the fungous hyphae. The lumina of the tracheids and the intercellular spaces were completely filled with the globular masses of mycelia, and layers of it in the form of pads were interspersed with the tiers of tracheids which split the wood radially. The interior of the sclerotium was similar in all respects to the dry specimens described by Wolf[6]; it was white to cream in color, hard and bony, with many large cracks. When boiled in water for some time, this material became soft and doughy.

On the surface of the sclerotium and on the wood adjacent to it there were a number of fructifications containing mature basidiospores. These fructifications resembled in all details those described by Wolf[6] and Weber.[6] The basidiospores were white, asymmetrically cylindrical, and about 3.5–4.0 x 7.5–8.0 µ in size. Additional fructifications were obtained within five or six days by placing portions of the sclerotium, which had been soaked in water, in a moist chamber in the laboratory.

On the surface of the sclerotium in a hymenial layer, numerous dark brown conidia were found. These were smooth, obovate, and about 3–4 x 5–6 µ in size. They were for the most part in the depressions of the corrugated surface of the sclerotium, and those observed were terminal. There was no attempt made to germinate them.

The discovery of this specimen on a *Taxodium* cross-tie, together with those reported by Ravenel[6] on a pine rail, indicates that the fungus is not entirely parasitic on roots or stems of living plants but may be saprophytic on wood as well. It may be considered then as a facultative parasite.

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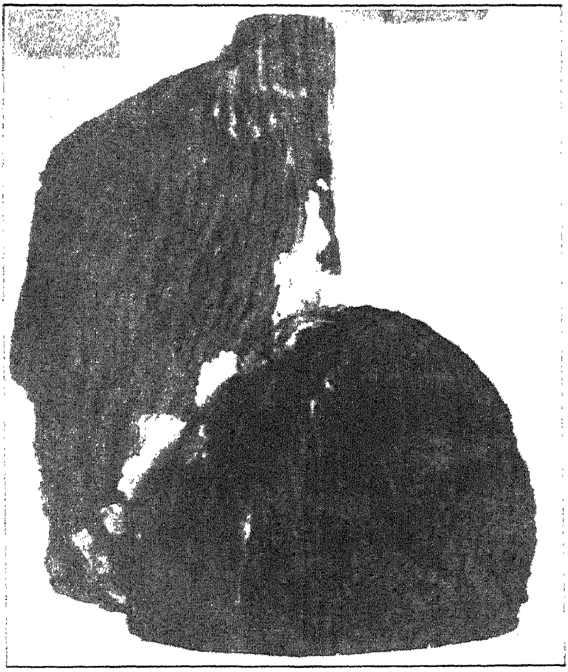
[6] *Loc. cit.*

## Explanation of Plate

### PLATE 14

Fig. 1. A photograph of a tuckahoe *Poria Cocos* (Schw.) Wolf. The white spots are the fructifications.

Fig. 2. A section of the tuckahoe in fig. 1, showing the thin rind and white interior. The interior cracked badly on drying but the surface remained intact.



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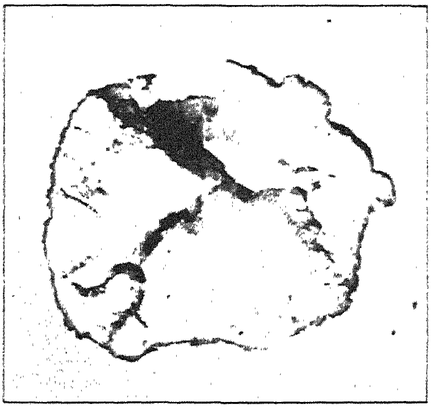

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BERKLEY—PORIA COCOS

# FIELD AND HERBARIUM STUDIES, III[1]

LOUIS WILLIAMS
*Washington University Fellow in Botany*

The first in this series of short papers dealing with the plants of the Rocky Mountains appeared in the Bulletin of the Torrey Botanical Club **59**: 427-429. 1932; the second, in the same journal **61**: 259-262. 1934.

**Corallorrhiza striata** Lindl. var. **Vreelandii** (Rydb.) comb. nov.

*C. Vreelandii* Rydberg in Bull. Torr. Bot. Club **28**: 271. 1901.

**Malaxis Soulei,** nom. nov.

*Microstylis montana* Rothrock, Rept. Bot. Wheeler Exp. 264. 1878.

*Malaxis montana* Kuntze, Rev. Gen. Pl. **2**: 673. 1891, not Blume. 1826.

*Acroanthes montana* Greene in Pittonia **2**: 183. 1891.

**Polygonum minutissimum** sp. nov. Annuum perparvum glabrum, 0.5–1 cm. altum; folio uno ad basem caulis, lineare, acuto; inflorescentia axillare, cum 4–10 floribus; sepalis albis, petalinis; achaeniis fuscis, ovatis, 1 mm. longis, triangularibus.

Minute glabrous annual 0.5–1 cm. tall; one leaf at the base of the stem, linear, acute, about equalling or surpassing the inflorescence, sheathed at the base by a hyaline ocrea; inflorescence axillary, 4–10-flowered, each flower subtended by a foliar bract about 2 mm. long; sepals white with a green midrib, petal-like, as long as the achenes; achenes dark brown, 3-angled, ovate, 1 mm. long, styles 3.

Collected in full fruit under overhanging cliff near Hidden Falls, Grand Teton National Park, Wyoming, July 15, 1932, *Williams, 878* (Ry. Mt. Herb. TYPE; Mo. Bot. Gard. Herb., Herb. Phila. Acad. Nat. Sci., Herb. Geo. E. Osterhout, Herb. L. Williams).

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[1] Issued June 5, 1934.

This species belongs in the section Avicularia, but is not closely related to any species known to the author.

**Aquilegia Piersoniana** sp. nov. Perennis alpestris humilis ex rhizoma crassa, 10–30 cm. alta; foliis biternatis, segmentis cuneatis, 3-lobatis, glabris, subtus glaucis; floribus flavis, 20–25 mm. longis, nutantibus; sepalis oblongo-ovatis, breviter unguiculatis, 2 cm. longis, non reflexis; laminis 6–7 mm. longis, patulis; calcare gracili, 12–14 mm. longo.

Low slender alpine perennial from a thick root-stock, 10–30 cm. tall, tufted or single; stems pubescent above, otherwise glabrous; leaves biternate, the largest leaflet 2–2.5 cm. broad, the segments of the leaflets cuneate, about 1 cm. long, 3-lobed for about one-third their length, glabrous, slightly glaucous beneath, the basal leaves half or more the length of the stem; stem-leaves much reduced, sessile, 3-parted, the lobes oblong; infloresence one–several-flowered, flowers nodding, yellow or occasionally tinged with blue; sepals oblong-ovate, short-clawed, 2 cm. long including the claw, 1 cm. wide, not reflexed, dorsally pubescent, blade 6–7 mm. long, spreading; spur slender, not enlarged at the end nor reflexed, 12–14 mm. long, slightly pubescent; capsule unknown.

Collected on wet ledges on the north base of the Grand Teton, altitude about 11,000 feet, Grand Teton National Park, Wyoming, August 10, 1932, *Williams, without number* (Ry. Mt. Herb. TYPE). Named in honor of Miss Rua Pierson in recognition of her interest in the local flora.

This species is perhaps most closely related to *A. flavescens* Wats. from which it differs in the following characters: The sepals and petals are both longer than the spurs, and neither seem to be reflexed; the spurs lack the enlarged tips and are more slender; the flowers are apparently erect in the bud and are much shorter.

**Hedysarum pabulare** A. Nels. var. **rivulare** var. nov. A specie foliis longioribus, angustioribus obtusioribusque, supra glabris, subtus pubescentioribus differt.

Collected on rocky flats along Snake River, Bar BC Ranch, Teton Co., Wyoming, July 31, 1932, *Williams, 975* (Ry. Mt.

Herb. TYPE; Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., Herb. Catholic Univ. Am., Herb. Geo. E. Osterhout., Herb. Calif. Acad. Sci., Herb. Utah Agr. Coll., Herb. Our Lady of the Lake Coll., Herb. L. Williams).

**Penstemon acaulis** sp. nov. Perennis depressa acaulis, 2 cm. vel minus alta; foliis lineari-acutis, 1–2 cm. longis, in corona fasciculis vel verticillis dispositis, puberulo-glandulosis; sepalis 5 mm. longis, ovato-attenuatis; corolla coerulea, in corona radicis, 15 mm. longa, fauce cum crinibus flavis infra; staminibus glabris, filamentis affixis ad vel prope basem corollae, posterioribus brevioribus; loculis antherae confluentibus; stamine sterile filiforme, crinibus fulvis ad altero latere ⅔ longitudinis tecto.

A depressed acaulescent perennial 2 cm. or less high, caespitose; roots slender; leaves linear-acute, 1–2 cm. long, 1 mm. wide, widest near the more or less calloused tip, usually borne in bunches or whorls on the crown or short proliferous branches; sepals 5 mm. long, ovate-attenuate, minutely glandular-puberulent; corolla blue, about 15 mm. long, usually subtended by a few leaves, much expanded above, 6–8 mm. wide at the throat, more or less glandular on the outer surface, the lobes rounded, 3 mm. long, more or less conduplicate, yellow-hairy in the throat, mostly on the middle lobe; stamens glabrous, the posterior pair reaching the throat, the anterior pair attached at the base and shorter than the posterior which are attached one-third the way up the corolla-tube, filaments filiform, anther-cells confluent; sterile stamen filiform, covered with crisp golden-brown hairs on one side for two-thirds of its length; stigma not enlarged; capsule unknown.

Collected in flower on dry hilltops near McKinnon, Sweetwater Co., Wyoming, altitude about 6,500 feet, May 28, 1932, *Williams, 407* (Ry. Mt. Herb. TYPE; Herb. Phila. Acad. Nat. Sci., Herb. N. Y. Bot. Gard., Mo. Bot. Gard. Herb., Herb. Geo. E. Osterhout., Herb. Calif. Acad. Sci., Herb. Catholic Univ. Am., Herb. Our Lady of the Lake Coll., Herb. Utah Agr. Coll., Herb. L. Williams).

This species belongs in the section Caespitosi (Pennell, Contr. U. S. Nat. Herb. **20**: 334. 1920). From the species recorded in that treatment it may be easily distinguished by the strongly cespitose habit and apparent lack of stem. Thanks are due Dr. Francis W. Pennell, who has given his opinion of the plant. He says it "is the most condensed in habit of any of that genus" and "differs from all others in lacking any definite stem."

# POSADASIA PYRIFORMIS AND P. CAPSULATA, TWO CAUSATIVE ORGANISMS OF DARLING'S HISTOPLASMOSIS IN THE UNITED STATES[1]

MORRIS MOORE

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As far as the author could determine, there has been no satisfactory classification of the fungi responsible for the condition known as Darling's Histoplasmosis. This disease is characterized by an acute specific infection involving usually the epithelial and endothelial cells of the lungs, liver and spleen. The organism may also be free in these organs, as well as in the blood stream. The following are two organisms from such a condition.

**Posadasia pyriformis** Moore, n. sp.

In the host reproduction by single yeast-like cells. On artificial media, mycelium of septate, elongate or short, thick hyphae, 1–5 μ in diameter. Macroscopically, cultures cottony with aerial hyphae, hyaline and white in a mass to a dark Isabella in color, with a diameter of approximately 2–6 cm. on various media, after 43 days' growth. Microscopically, many conidia, lateral, sessile or pedicellate, spherical or pyriform, 3–8 μ in diameter; chlamydospores, intercalary 3–10 μ in diameter, singly or in chains and lateral on 1- to several-celled branches, or terminal 3–10 x 6–20 μ; racquet mycelium present; sexuality lacking; clavate or globose cells 5–18 μ in diameter, becoming multispored tuberculate asci, spherical 6–25 μ in diameter, usually 15 μ, and pyriform 6–12 x 12–26 μ, usually 10 x 22 μ. Tubercles up to 7 μ in long axis, varying in number and proportions. Carbohydrates not fermented. Milk not curdled or acidified. Gelatine not liquefied.

**Posadasia pyriformis** Moore, sp. nov.

Mycelium in culturis abundans sed in hospite cellulae singulae sunt. Hyphae longae vel breves, diametro 1–5 μ. Culturae floccosae aeriaeque, diametro 2–6 cm. diversis in mediis postquam 43 diebus. Conidia multa lateralia sessilia vel pedicellata, spherica vel piriformia, diametro 3–8 μ; chlamydosporae intercalarae lateralesve diametro 3–10 μ vel terminales 3–10 x 6–20 μ; mycelium "racquet" adest. Sexus deest. Cellulae clavatae vel globosae, diametro 5–18 μ, ascos multisporos tuberculatos fiunt, diametro 6–25 μ vel piriformes 6–12 x 12–26 μ. Tuberculi longi, 1–7 μ, numero et magnitudine diversi sunt. Gelatinum non fluidificans. Lac non concretum, acidus nullus. Fermentatio nulla.

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[1] Issued June 5, 1934.

**Posadasia capsulata** (Darling) Moore, n. comb.

*Histoplasma capsulatum* Darling, Jour. Am. Med. Assoc. 46: 1283–1285. 1906.

This species differs from *P. pyriformis* in having a slightly smaller growth on corresponding media and a light Isabella color. Microscopically the cells are smaller in proportion; hyphae 1–4 μ; conidia 2–7 μ; chlamydospores spherical, 3–8 μ in diameter, pyriform, 3–9 x 7–18 μ; clavate or globose cells 5–15 μ; asci multispored, spherical, only 5–22 μ, rarely 25 μ. Sexual development absent. Gelatine not liquefied. Milk not curdled or acidified. Carbohydrates not fermented.

Complete morphological, cultural, biochemical, and cytological details will follow.

# A NEW GEOTRICHUM FROM A BRONCHIAL AND PULMONARY INFECTION, GEOTRICHUM VERSIFORME MOORE. N. SP.[1]

MORRIS MOORE

*Formerly Rufus J. Lackland Research Fellow in the Henry Shaw School of Botany of Washington University*

## INTRODUCTION

The purpose of this paper is to report the occurrence of a case of a bronchial and pulmonary infection from St. Louis, Missouri, and also to present the characteristics of a *Geotrichum* isolated from it. The organism is described as a new species, and from all indications it was the probable etiologic agent of the disease.

The genera *Geotrichum, Mycoderma, Oidium, Oospora, Monilia,* and several others have been confused by numerous authors. Nomenclature has been changed, terms have been discarded and others have sprung up, but apparently no universal agreement has been reached by all interested mycologists. The author wishes to indicate some important facts as to the structure and differentiation of the fungus, as well as to point out apparent misnomers and the correct position of such incorrectly determined organisms.

## CASE REPORT

*Clinical History.*—Barnes Hospital Clinic No. C 17521. Patient F. S., a white male, 22 years of age, a chemist, entered the clinic March 9, 1931, for some ailment to be shown later, and was then released. He re-entered December 31, 1932, with a persistent, productive cough which brought up a thick, greenish, muco-purulent, tenacious sputum.

*Family History.*—Mother died in childbirth 15 years previously. Father living and well. One brother living and well.

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[1] A paper reported at the meetings of the Mycological Society of America, on December 30, 1933, held in conjunction with the ninety-third meeting of the American Association for the Advancement of Science, at Boston, Massachusetts, December 27, 1933–January 2, 1934.

Issued June 5, 1934.

*Past History.*—Whooping cough when child. Pneumonia 6 years previously; in bed 2 weeks and no sequelae. Measles in January, 1931, followed by a mastoiditis. Mastoidectomy performed at the Barnes Hospital in February, 1931. Two or three attacks of tonsillitis since 14 years of age, with abscess at one time. Tonsillectomy performed at the Barnes Hospital, June 6, 1931.

*Personal History.*—Wassermann and Kahn negative.

*Present Illness.*—About 7 years previously, while a student in high school, the patient kept irregular hours and began to have a more or less persistent cough, on one occasion the sputum being bloody. Cough continued for several years, usually worse in the morning, and about one to two tablespoonsful of sputum, occasionally bloody, was coughed up. The summer before entry, patient was in the open a great deal and the cough subsided. About a month previous to entry, he developed a fever with generalized pains. He was confined to his bed and since that time the cough became more persistent and painful and troubled him mostly at night.

A chest examination revealed a few squeaks. Fluoroscopic examination showed little. In view of the history of chronic cough, sputum examination was advised and X-ray with flat plate on sternum.

*January 4, 1933.*—To date the presence of an infection or dangerous condition not indicated. Further examination to be carried out.

*January 9, 1933.*—Patient fairly well, but complained of persistent cough in morning and occasionally a coughing spell in the afternoon, with which a large amount of pale yellow, occasionally streaked sputum was brought up. Physical findings of lungs showed some roughening on both sides and some increase in left and right lower lungs, with râles.

*Diagnosis.*—Bronchiectasis. Lipoidal suggested.

*January 10, 1933.*—Lipoidal introduced into left lung. X-ray showed definite bronchiectasic areas or multiple abscesses. During course of introduction, patient coughed up about 60 cc. purulent material containing bright blood streaks.

*January 14, 1933.*—Patient returned to the chest clinic. He stated that he had been growing mushrooms for the past year in an underground quarry where the humidity was fairly high. Felt fairly well at the time, but still brought up a moderate amount of sputum. Further examination of sputum for molds.

*January 28, 1933.*—Definite bronchiectasis of base of left lung. Posterial drainage.

*X-ray findings of January 3, 1933.*—Posterior-anterior view of chest. Cardiac shadow within normal limits. Tremendous increase of shadow of left hilus and generalized thickening of lung markings throughout the field. Particular widening of those markings lateral to the right cardiac border at the base, associated with a large amount of coarse, soft, slightly coalescent mottling. Cloudiness within the circle of the first rib on either side, at the extreme apex. Leaves of diaphragm rounded and the costophrenic angles clear.

*X-ray Diagnosis.*—Pulmonary infiltration of left base, indeterminate nature.

The sputum was cultured and the organism described in this paper was isolated in relatively great amounts. The patient was given potassium iodide *per os.* He left St. Louis sometime during the spring of the year 1933, and in a letter to the author, dated June 23, 1933, he stated that his general health had improved, with a gain of five pounds in weight. The pain in the chest had disappeared except for infrequent periods, the cough was somewhat better, and the amount of sputum had decreased. He had stopped treatment about a month previously. A second communication dated October 26, 1933, stated that his condition had not changed, that he had resumed the previous treatment for a short time but upon finding no marked improvement had again stopped it.

## Technique

The fungus was studied in hanging-drop preparations or Van Tieghem cells, in a lactose-broth medium, a product of the Digestive Ferments Co., as well as on Sabouraud's broth, 2 per cent bacto-peptone, and meat extract broth.

For morphological detail and for possible cellular granulations, the fungus was mounted in a 1 per cent aqueous crystal violet solution plus glycerine, the desired amount of dye being added to obtain the necessary intensity. Amann's lacto-phenol was also used, as well as various dyes in aqueous solutions, but the first two were sufficient for all purposes of general structure. Distilled water mounts were made which showed up the oil globules present on the cellular surface.

## Description

*Geotrichum versiforme* macroscopically assumes different conditions, varying from crinkled and vermiculate on malt extract agar to asteroid on Sabouraud's agar. The velvety or plush-like appearance prevails on most culture media, conspicuously so on potato-dextrose and glycerine agar, and many of the cultures, particularly those on meat extract, lactose, and Endo's agar, are moist. On Raulin's and Richards' agar, which contain inorganic sources of nitrogen and several salts, the mycelium is completely submerged. The colonies are tenacious and hard to separate from the substrate. The striations evident on Sabouraud's agar are due to coremia formed by the matting of hyphae. On liquid media, a pellicle is formed on the surface with a fine sediment in the bottom of the flask.

When isolated from the sputum, the fungus is in the form of simple cells, ovoid to spherical, 4–6 μ in diameter. When grown on agar, the cells form a complicated mycelium which eventually breaks up into arthrospores typical of this group. On artificial substrates, the arthrospores serve as the seeds of the future colonies. The various steps in their formation may be traced as follows: The single cell germinates, sending out a thin-walled tube which may emerge from either end, or laterally (pl. 16, figs. 1–6). The germ-tube may be simple (figs. 7–8) or it may bi- or trifurcate. It elongates and forms cross-walls which may be simple or collar-like (figs. 7–8, 15), either equidistant or irregularly spaced, when secondary cross-walls may develop (fig. 17). With the development of equidistant partitions, the hypha is now divided into a number of cells. Langeron and Talice ('32) observed that the germ-tube may remain simple and undivided, as stated previously, and as such will bifurcate or trifurcate. This was occasionally noted here, but these germ-tubes later became arthrospores. It is to be noted that the hyphae are capable of developing lateral branches (figs. 12, 14–17), which may form simply or as offshoots at or below a cross-wall. In addition, the so-called blastospores may be formed as suggested in fig. 12.

The presence of a true conidium in *Geotrichum* seems to be much disputed. One cannot help feeling, however, that a pyriform structure such as that in pl. 16, figs. 11, 14, and 16, having the functions of a conidium as noted in other organisms, e. g. *Endomyces,* are very highly suggestive of that organ. There is no doubt that the cells are capable of germinating into a tube which has the same vegetative and reproductive functions as the arthrospores. That being the case, the only reason why that particular cell may not be called a conidium is cytological, and such a study will be reported later.

The young filaments are thin-walled at first, and as the cross-walls are laid down, the thick hyaline walls cause the resulting cells to assume a double-contoured appearance. Just previous to disarticulation, or the breaking up of the filament into the arthrospores, the cells may assume a rectangular appearance (pl. 16, fig. 18), or they may be barrel-shaped (fig. 23). On various media and hydrogen-ion concentrations they may assume different forms, as on malt extract agar (fig. 19) and on Richards' agar (figs. 24, 28) where they are in the form of oidia. It must also be noticed that not all hyphae develop these equidistant cells, for irregularity is likewise well-marked (figs.

19, 22). Also, the smaller cells may be formed only on a portion of the filament, as seen in figs. 27, 30, 32, a condition which is apparent in the Oosporaceae of Saccardo, particularly as seen in fig. 27.

When mature, the thick-walled cells become arthrospores. A gelified secretion seems to be laid down simultaneously between the cells as part of the connecting cell-wall, at the point where disarticulation takes place. The arthrospores appear at first to be cylindrical (rectangular in optical section) (pl. 16, figs. 18, 23), and in many cases (figs. 22, 24) are rounded at the ends. When completely separated from each other, the cylindrical arthrospores become spheroidal, ovoid, or ellipsoid (fig. 26). In a few cases, it is possible to note some of the protoplasm connecting the arthrospores, which has not completely attached itself to the cells, or perhaps part of the cell-wall which has not entered into the formation of the cells, as in fig. 18. The cells may then either remain in the condition described above or they may become spherical, ovoid, or even ellipsoid, and within a suitable period of time germinate to give rise to a new colony.

Several other anatomical structures have been given consideration by various workers and should be noted here. First, not all the hyphae or even a whole filament will divide to form arthrospores. Disarticulation may occur either near the end of a filament as in pl. 16, figs. 27 and 30, or at various segments of a filament. In either case, the intervening portion of the hypha is clear and thin-walled and seems to disintegrate after the arthrospores have been set free. Apparently the cellular material is used up in the formation of the thick-walled cells. On a few occasions, arthrospores or perhaps chlamydospores were found enveloped by a thin membrane (fig. 32), the entire wall evidently not having entered into the development of the spores.

Chlamydospores are found frequently. These are distinguished from the rest of the mycelium by their conspicuous size and seemingly granular protoplasm (pl. 16, figs. 13, 19–20, 23, 33), and in some instances (fig. 33), they simulate the akinetes as found in algae. Cells analogous to terminal chlamydospores (hypnospores) are also evident (figs. 29, 31, 34). Chains of oidia-like cells on Richards' agar (fig. 28) are of common occurrence on that medium, and evident also on Raulin's solution agar. Occasionally blastospores occur, either thick- or thin-walled (perhaps suggested by fig. 22).

In addition to the various organs discussed above, the mycelium may be altered, changes in the constituents of the substrate giving rise to numerous structures indicative of standard fungus organs as well as nondescript, sclerotic cells and the racquet mycelium characteristic of various other groups of fungi.

## CULTURAL DESCRIPTIONS

The culture obtained in this study was growing on a Sabouraud's glucose-agar slant. The colony assumed a velvety "duvet" appearance, with lines radiating to the periphery, apparently a coremioid condition. Transfers were made to various media which ranged in pH from 4.1 to 7.5, also to more strongly alkaline and more strongly acid media. All cultures were grown at approximately 25° C.

The importance of physiological variations in taxonomic differentiation cannot be stressed sufficiently. Species differentiation founded on growth on a single medium is usually unreliable, and the use of standard media is essential for obtaining the morphological changes. The characteristics here discussed were observed from the growth of the organism on several media which represent a series varying in hydrogen ion concentration, protein and carbohydrate content. The media are arranged in the order of their decreasing concentration of hydrogen ions. The cultures were examined 3–8 days after inoculation and again 210 days later.

*Raulin's Solution Agar (pH 4.1).*—(pl. 16, figs. 1, 18, 26, 29). Colony dull gray in color, turning faintly cream with age, and attaining a diameter of 6.5 cm. 8 days after inoculation. Smooth and velvety, with a peripheral zone of fine radiate growth. Young culture shows many fine hyphae 2–3 μ in diameter, which develop a great number of cylindrical cells approximately 4 μ in diameter and 7–10 μ long, several round cells approximately 6–15 μ in diameter, large cells 6 x 15 μ. Short chains of round cells approximately 6 μ in diameter. Chains of arthrospores numerous.

*Richards' Solution Agar (pH 4.3).*—(pl. 16, figs. 2,22,24,28). Colony of submerged, hyaline mycelium, 5½ cm. in diameter at end of 8 days, with fine radiating lines from the inoculum as seen with the aid of light coming through the agar. Long chains of spherical to rectangular cells 6 x 30–40 μ, large cells varying in diameter from 9 to 21 μ, also variously formed sclerotic cells. Arthrospores and chlamydospores in abundance in older cultures.

*Czapek's Agar (pH 4.4).*—(pl. 16, figs. 10, 14, 31). Macroscopic appearance similar to that on Richards' agar. Colony 5½ cm. in diameter after 8 days' growth. Long filaments 3 μ in diameter, with enlarged terminal cells 6 x 9 μ. Ovoid cells, arthrospores 6 x 8 μ. Rectangular cells with rounded corners 4 x 6 μ. Elongated cells 3 x 13–15 μ.

*Malt Extract Agar (pH 5.2).*—(pl. 15, fig. 1; pl. 16, figs. 11, 13, 19–20, 23, 35). Growth irregular and thick in center with a pebbly, vermiculate surface, attaining a diameter of approximately 2½ cm. in 8 days. Colony dull creamy-buff in color, appearing pasty at periphery of colony similar to a yeast culture. Mycelium thick and tenacious, adhering to the substrate and resistant to the needle. Large sclerotic cells, ovoid chlamydospores and arthrospores 20 x 30 μ, and many round cells 15 μ in diameter at center of colony. Variously formed cells and arthrospores varying from 4 to 6 x 6 to 15 μ. Young filaments and yeast-like cells at edge of colony.

*Sabouraud's Agar (pH 5.6).*—(pl. 15, fig. 2; pl. 16, figs. 3–5, 7, 9, 16, 27, 30). Growth good, 6½ cm. in diameter after 8 days, hyaline to white when young, becoming creamy yellow to light buff when older, with a "duvet" or furry appearance, in sectors, extending from the inoculum. Several colonies showed a moist, shiny, convoluting, cerebriform surface. Mycelium thick with a heavy mucoid tenacity.

*With Maltose.*—(pl. 16, figs. 27, 30). Round cells approximately 5 μ in diameter, and elongated cells 5 x 8–9 μ. Many thick-walled rounded arthrospores. Young filaments thin-walled and long, approximately 4–5 x 30–40 μ. Chains of arthrospores numerous in older cultures.

*With Glucose.*—(pl. 16, figs. 3–5, 7, 9, 16). Cells approximately 3 μ in diameter. Variety of filaments, some branching, long and thin, 2–3 μ in diameter, others short and thick-walled, about 5–6 μ in diameter. Sclerotic cells present, as well as numerous thick-walled arthrospores 5 x 8–10 μ, and chlamydospores (terminal, as hypnospores), pyriform to ovoid and ellipsoid. Lateral cells on a filament similar to conidia, pyriform to round, 6–7 x 5–15 μ. No budding recognizable as such.

*Sabouraud's Broth (The above minus the agar, pH 5.6).*—(pl. 16, fig. 15). Scum formed on surface of broth with a sediment. Liquid faintly cloudy, becoming clear after a few days. Long filaments with cells approximately 4 x 90 μ. Arthrosporous cells few, 4 x 12 μ. Chlamydospores very few.

*Potato-Dextrose Agar (pH 5.9).*—(pl. 15, fig. 3; pl. 16, fig. 12). Colony 7 cm. in diameter after 8 days. Cultural appearance similar to that on Sabouraud's agar, with the "duvet," but dull gray to light cream in color. Sectors present showing variability in color, creamy-white as present on Sabouraud's agar. Older cultures plush-like or furry, with a whirl. Long filaments 3 μ in diameter, round cells (chlamydospores) 5–6 μ in diameter; arthrospores numerous, 3–4 x 12–15 μ. Many pyriform loose cells 6 μ in diameter.

*Corn-Meal Agar (Product of Digestive Ferments Co., pH 6.0).*—(pl. 16, figs. 21, 32–33). Colony 3½ cm. in diameter after 8 days, with distinct zones of decreasing growth from the inoculum to the periphery. Color dull creamy white. Young cultures show long thin-walled hyphae with cells approximately 4–8 x 30–35 μ, many cells varying in same proportions. Large cells show a clear cytoplasm, not taking a stain. Older cultures show an abundance of arthrospores 5–6 x 10–12 μ, as well as large cells of this nature, 9 x 15 μ, round cells 5 μ in diameter. Numerous intercalary chlamydospores, as in fig. 33, simulating akinetes in algae.

*Lactose Broth (Product of Digestive Ferments Co., pH 6.8).*—(pl. 16, fig. 17). A thin scum or veil on the surface of the liquid with a macroscopically fine sediment and a clouded condition prevailing throughout for several days. Clusters of hyphae, coremium-like, 4–5 μ in diameter, branching and with cross-walls. Older hyphae, 6 μ in diameter, showing septal formation. Numerous chains of arthrospores 4–6 x 6–11 μ. Ovoid cells 6 x 9 μ.

*Lactose Agar (The above plus 2 per cent agar).*—(pl. 15, fig. 4). Flat growth of fine filaments, dull gray to light cream in color, with a diameter of 4 cm. after 8 days. Young hyphae 3–4 x 25–35 μ. Older cultures with sclerotic cells and pyriform cells simulating the conidia of *Endomyces capsulatus*. Many large round cells 9–15 μ in diameter, numerous arthrospores 4–5 x 8–11 μ, and many filaments with a terminal club-like appearance.

*Glycerine Agar (Beef extract agar plus 6 per cent glycerine, pH 7.0).*—(pl. 15, fig. 5; pl. 16, fig. 8). Colony 4.2 cm. in diameter after 8 days, creamy-yellow to light buff in color with a powdery appearance. Center somewhat crateriform, becoming raised, thick and tenacious with age. Slight striations extending from the periphery to the center of the colony. Lateral view of the culture presents a hyaline sheen. Old cultures show numerous arthrospores 3–8 x 8–18 μ; round cells 6–9 μ in diameter; intercalary chlamydospores 6–8 μ in diameter. Filaments or hyphae cross-walled and branching, young filaments with fewer cross-walls and smaller diameter than the older ones. Sclerotic appearance of mycelium similar to that on malt extract agar.

*Nutrient Agar (Product of Digestive Ferments Co., pH 7.2).*—(pl. 15, fig. 6; pl. 16, figs. 6, 25, 34). Colony moist and flat, cream to light buff in color, with a diameter of 5 cm. in 8 days. Filaments multibranched with racquet-like swellings, a condition prevalent on most cultures and particularly well marked on malt extract and glycerine agar. Hyphae 4 μ in diameter. Older cultures show numerous chains of arthrospores 4–6 x 6–9 μ; round cells 6–12 μ in diameter.

*Endo's Agar (Product of Digestive Ferments Co., pH 7.5).*—(pl. 15, fig. 7). Cultures flat and pink in color, 3 cm. in diameter after 8 days, moist and shiny with concentric rings of growth and a periphery of fine filaments. Microscopically similar to cultures on nutrient agar.

*Gelatine.*—After 12 days plain gelatine liquefies slowly on surface at point of inoculation and proceeding downward. Beef extract gelatine (15 per cent) liquefies slowly on surface after 14 days.

*Carbohydrate Reactions.*—No fermentation on any sugar. Acid and no gas with l-xylose, galactose, d-mannose, levulose, and maltose. No acid, but an alkaline reaction with l-arabinose, rhamnose, dextrose, lactose, sucrose, raffinose, and inulin. Alkalinity may be considered as a negative acidity reaction and may perhaps be accounted for by the breakdown of the protein, amino acids to alkaline bases as arginine, lysine and histidine and finally ammonia, which are the breakdown products in the growth process of the organism.

*Litmus Milk.*—Acidified and curdled after the fourth day.

## DISCUSSION

The genus *Geotrichum* has often been confused with several other genera, e. g. *Mycoderma, Oidium, Oospora* and even *Monilia.* Several of these conflicting forms are so close morphologically that one must rely almost wholly on biochemical reactions for the correct determination of the organism. On the other hand, fungi have been included in one of these groups which apparently have no generic similarity, making the literature abundant with misnomers.

In 1809 Link created the genus *Geotrichum* with the following characteristics (Link, Mag. Naturf. Ges. Fr. Berlin **3**: 17–18. 1809; Saccardo, Syll. Fung. **4**: 39. 1886): "Hyphae steriles repentes; fertiles breves, adscendentes septulatae. Conidia concatenata, breve cylindracea, utrinque truncata, hyalina."

Since the above description, numerous species have been added to the genus. The confusion existing in the literature has been briefly summarized by several authors, particularly Langeron and Talice ('32). From the genus *Mycoderma,* however, *Geotrichum* is to be differentiated particularly, since these two groups have often been interchanged and even reduced to synonymy by Ciferri and Redaelli ('29).

*Mycoderma* has been considered to be similar in morphology to *Geotrichum.* However, there is greater gelification of the walls of *Mycoderma,* particularly at the cross-walls, the cells tending to become rounded or ellipsoidal as compared with the cylindrical cells of *Geotrichum,* where the ends remain abrupt or become somewhat rounded. This of course may vary in both genera, making morphological differentiation so difficult that biochemical and physiological reactions must be resorted to. In this respect, it is found that the Geotricha may produce a thick pellicle on liquid media; liquefy gelatine and serum, but do not ferment sugars, usually producing acidity and no gas. In the case of the Mycodermata, it is generally found that the colony surface on media is more folded, with no gelatine or serum liquefaction or fermentation of sugars.

As the majority of the members of the genus *Geotrichum,* as well as of *Mycoderma,* have been isolated from the soil, there are many saprophytes which are not as yet found to be pathogenic on man. In many cases, there have been determinations of fungi based on systems of classification which have either reduced several genera to synonymy or have adopted terms which in many cases do not apply to this group. A few of these may be briefly considered.

Sartory in 1907 placed these fungi in the genus *Oospora,* on the same footing as the Actinomycetes, and confirmed this in 1923 (Sartory et Bailly, '23). Castellani ('19) considered the fungus as *Oidium* Link, 1809, *emendavit* Pinoy, and defined it as "Oosporaceae with hyphae terminating in chains of spores. Hyphae long and branched. Sporophores simple, septate, often without disjunction apparatus. Do not produce gas in carbohydrates." He included four species as pathogens: *Oidium lactis* Link, 1809; *O. rotundatum* Castellani, 1911; *O. asteroides* Castellani, 1914; *O. matalense* Castellani, 1915. Since that time, numerous changes have occurred, and that author has published several new species and varieties of *Geotrichum,* whereas the four above fungi have been placed in *Geotrichum* by other writers. Some of these new organisms may belong to the last-named group, while certain others are definitely not correct taxonomically.

Berkhout ('23) took up the name *Oospora* for these pathogenic fungi and included in it the genus *Oidium*. Ciferri and Redaelli refer the species to the Torulopsidaceae of the Mucedineae amerosporeae, on the same standing as the Oosporaceae and perhaps in synonymy with the latter. The Torulopsidaceae they further divide into the Torulopsideae, which replaces the former sub-family Cryptococcaceae, and the Mycotoruleae, including thus *Geotrichum*, which they use in preference to *Oospora* and *Mycoderma*. Vuillemin ('31), on the other hand, prefers to keep the group in *Mycoderma*, while Langeron and Talice ('32) classify it with the Mycotorulaceae of Ciferri and Redaelli, placing the genus in their *Geotrichoides*, a sub-group of the family which forms membranaceous colonies and comprises the single genus *Geotrichum*. They characterize the genus as having a true mycelium that breaks up into arthrospores with occasional blastospores, and forming a thick veil on liquid media.

A review of the literature revealed further that very few well-defined species of *Geotrichum* have been reported pathogenic for man. The several species known in literature: *G. pulmoneum* (Bennett) Basgal ('31), *G. asteroides* (Castellani) Basgal ('31), *G. louisianoideum* and *G. multifermentans* Castellani ('33), and several other fungi appearing in such genera as *Mycotorula*, *Torula*, *Oidium*, *Mycoderma*, *Oospora* and *Monilia*, which from their morphological and biochemical properties should be in *Geotrichum*, have definite characteristics which distinguish them, and possibly not all are correctly named. In addition, two organisms have been published recently with a generic change, namely *G. immite* (Rixford and Gilchrist) Agostini ('32) and *G. dermatitidis* (Gilchrist and Stokes) Castellani ('33). These fungi are of particular interest, since neither one presents characteristics identical with *Geotrichum*. *Geotrichum immite*, the cause of coccidioidal granuloma, furthermore, has been shown to have an ascus in its life cycle which immediately eliminates it from the above group and places it in the Ascomycetes where the author

('32) created the family Coccidioideaceae, with *Coccidioides immitis* as the type genus and species. The second fungus, *G. dermatitidis,* the cause of the American type of blastomycosis, has absolutely no association with the genus. This was also found to have an ascus with 8 spores in its life cycle and was consequently transferred by the author ('33, '33a) to the genus *Endomyces.*

After carefully studying the description of the above species, particularly of *Geotrichum* and the possibly related species in *Mycoderma, Oidium* and *Oospora,* the author concludes that the organism described in this paper should be a new species, *Geotrichum versiforme.*

**Geotrichum versiforme** Moore, n. sp.

Differs from other species of the genus *Geotrichum* by having many forms on various media. Macroscopically it varies from a velvety plush-like, to a moist, flat, asteroid or vermiculate condition. Color varies from a dull grayish-white to a dull creamy-buff with a "duvet" appearance, as on Sabouraud's and glycerine agar. Microscopically the cells vary in size, proportion, and development; hyphae 3–8 μ in diameter, with young cells approximately 6–40 μ long; arthrospores 4–9 x 6–18 μ; spherical chlamydospores 4–18 μ in diameter, elongated ones 6–8 x 20–30 μ; small spherical cells 4–6 μ in diameter, possibly blastospores; conidium-like cells, spherical 4–6 μ in diameter, pyriform 3–4 x 4–6 μ. No fermentation on any sugar. Acid and no gas after 2 days on l-xylose, galactose, d-mannose, levulose, and maltose. No acid or gas on l-arabinose, rhamnose, dextrose, lactose, sucrose, raffinose, and inulin. Plain gelatine liquefies slowly at the surface after 12 days, and beef extract gelatine after 14 days.

**Geotrichum versiforme** Moore, spec. nov.

Cellulae plures figuras in mediis diversis habent. Coloniae inter se a panno-villosis holosericisque vel humidis, planis, stellatis vel vermiculatis diversae sunt. Superficies impolita, color albidus vel subalutaceus. Cellulae forma et magnitudine variantes. Hyphae diametro 3–8 μ; cellulae iuniores 6–40 μ longae; arthrosporae 4–9 x 6–18 μ; chlamydosporae sphaericae, diametro 4–18 μ, chlamydosporae elongatae 6–8 x 20–30 μ; cellulae parvae sphericae 4–6 μ diametro quae blastosporae fieri possunt; cellulae conidio similes, globosae, diametro 4–6 μ, piriformes 3–4 x 4–6 μ. Fermentatio nulla. Acidus per biduum in "l-xylose, galactose, d-mannose, levulose, et maltose." Acidus nullus in "l-arabinose, rhamnose, dextrose, lactose, sucrose, raffinose, et inulin." Gelatina communis per duodecim diebus in summa cuto fluidificans, gelatina decocta bubula per quattordecim diebus fluidificans.

## Summary and Conclusions

1. A case of bronchiectasis and pulmonary infiltration is reported, from which was isolated an organism identified as a new *Geotrichum*.
2. The fungus, grown in hanging-drops, may develop from an arthrospore to form hyphae, either single or branched, which at maturity form cross-walls and thick walls, breaking up into arthrospores by disarticulation.
3. When grown on a variety of standard media, differing in pH, protein and carbohydrate content, the organism showed different forms on different substrates, developing the largest cells on malt extract agar. The colonies varied from a furry or plush-like growth to a "duvet," flat, moist or vermiculate growth. The color varied from a grayish-white to a creamy-buff.
4. There is no fermentation of any sugar. Acidity is produced with l-xylose, galactose, d-mannose, levulose, and maltose, while an alkaline reaction takes place with l-arabinose, rhamnose, dextrose, lactose, sucrose, raffinose, and inulin. This latter observation may be explained by the breakdown of the amino acids of the medium to alkaline bases, as arginine, histidine and lysine, and also ammonia. Plain gelatine is liquefied after 12 days and beef extract gelatine after 14 days.
5. Because of the several forms on the different media, color production, carbohydrate reactions, and gelatine liquefaction, the organism is described as a new species, *Geotrichum versiforme* Moore.

## ACKNOWLEDGMENTS

The author is indebted to Dr. Carroll W. Dodge, Professor of Botany in the Henry Shaw School of Botany of Washington University, for the use of his unpublished manuscript and data; to Dr. George T. Moore, Director of the Missouri Botanical Garden, for the facilities of the mycological laboratory and the library; and Dr. Ralph S. Muckenfuss, Assistant Professor of Medicine, Washington University School of Medicine, for the culture of the organism here described.

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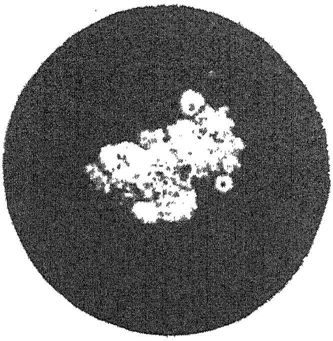
## Explanation of Plate

### PLATE 15

*Geotrichum versiforme*

Photographs of colonies, 8 days old, on various media.
Fig. 1. Malt extract agar, pH 5.2. × 1.
Fig. 2. Sabouraud's agar, pH 5.6. × ⅝.
Fig. 3. Potato-dextrose agar, pH 5.9. × ⅝.
Fig. 4. Lactose agar, pH 6.8. × 1.
Fig. 5. Glycerine agar, pH 7.0. × ⅞.
Fig. 6. Nutrient agar, pH 7.2. × ⅞.
Fig. 7. Endo's agar, pH 7.5. × ⅝.



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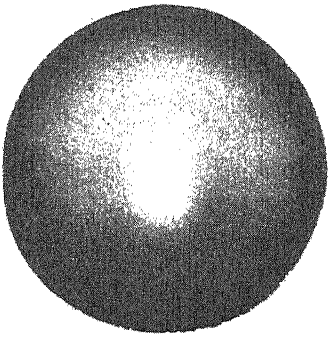

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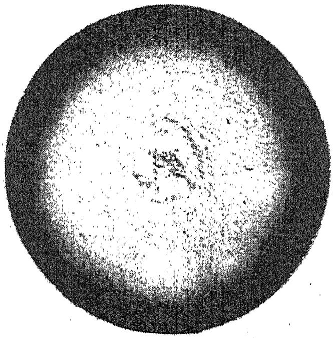

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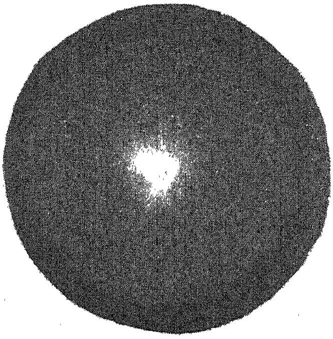

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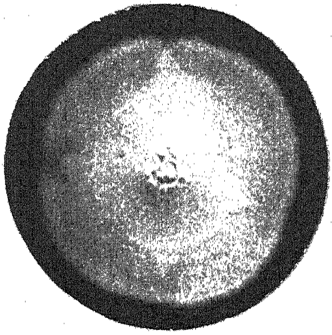

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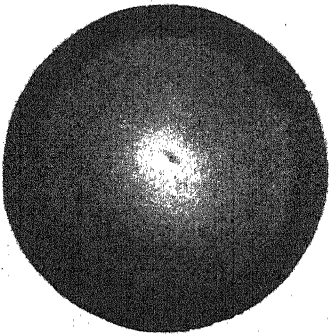

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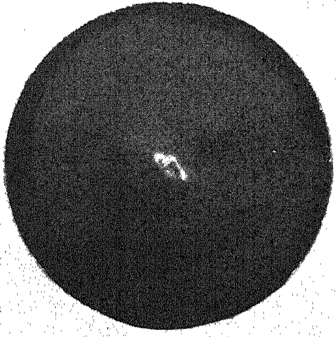

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## EXPLANATION OF PLATE

### PLATE 16

*Geotrichum versiforme*

All figures drawn as correctly as possible at a magnification of × 960 and reduced to × 500, with the aid of a camera lucida.

Fig. 1. Simple arthrospore before germination, on Raulin's agar.

Fig. 2. Germinating arthrospore on Richards' agar.

Figs. 3–5, 7. Germinating arthrospores on Sabouraud's glucose agar.

Fig. 6. Germinating arthrospore on nutrient agar.

Fig. 8. Young filament on glycerine agar.

Fig. 9. Hypnospore-like cell on Sabouraud's glucose agar.

Fig. 10. Young filament showing vacuoles of future arthrospores, on Czapek's agar.

Fig. 11. Mycelium with terminal arthrospores and chlamydospores on malt extract agar.

Fig. 12. Mycelium on potato-dextrose agar.

Fig. 13. Large round chlamydospores on malt extract agar.

Fig. 14. Mycelium showing formation of arthrospores and a conidium-like cell on Czapek's agar.

Fig. 15. Type of cross-wall present on mycelium grown in Sabouraud's broth.

Fig. 16. Mycelium showing pyriform, conidium-like cell on Sabouraud's glucose agar.

Fig. 17. Young mycelium showing vacuoles and arthrospore formation in lactose broth.

Fig. 18. Chains of arthrospores on Raulin's agar.

Fig. 19. Mycelium showing large round chlamydospores, arthrospores, and sclerotic cells on malt extract agar.

Fig. 20. Mycelium showing septal formation and sclerotic cells on malt extract agar.

Fig. 21. Group of rectangular arthrospores on corn-meal agar.

Fig. 22. Mycelium showing arthrospores, rounded and rectangular, on Richards' agar.

Fig. 23. Barrel-shaped arthrospores and an intercalary chlamydospore on malt extract agar.

Fig. 24. Chain of ovoid to round arthrospores on Richards' agar.

Fig. 25. Arthrospore formation on nutrient agar.

Fig. 26. Cell showing cylindrical appearance, on Raulin's agar.

Fig. 27. Arthrospores formed terminally on a filament, on Sabouraud's maltose agar.

Fig. 28. Chain of round cells on Richards' agar.

Fig. 29. Pyriform terminal cell on Raulin's agar.

Fig. 30. Branching filament with arthrospores on Sabouraud's maltose agar.

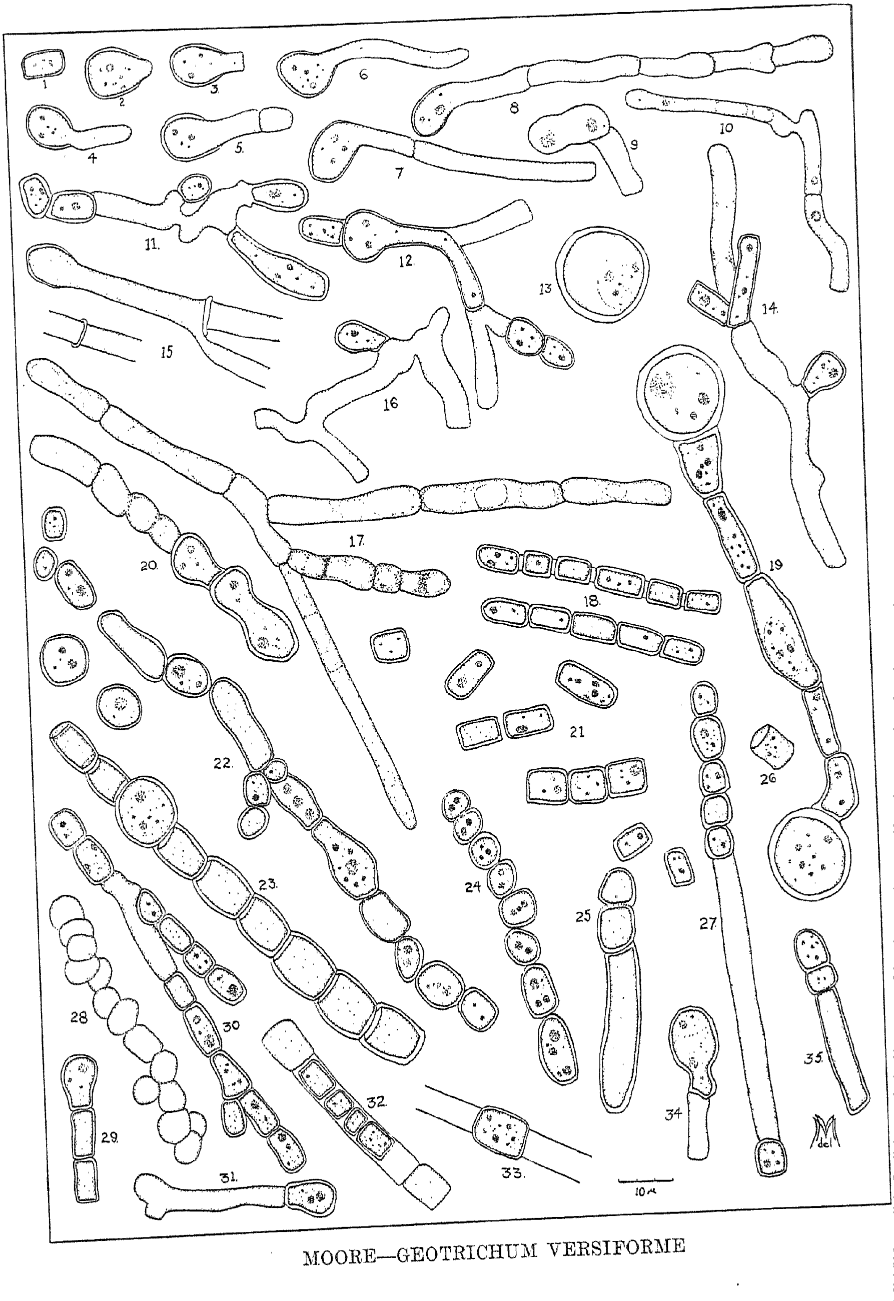
Fig. 31. Pyriform chlamydospore on Czapek's agar.

Fig. 32. Arthrospores formed within a filament on corn-meal agar.

Fig. 33. Chlamydospore comparable to an akinete as found in algae, on corn-meal agar.

Fig. 34. Terminal chlamydospore on nutrient agar.

Fig. 35. Terminal arthrospores on malt extract agar.



MOORE—GEOTRICHUM VERSIFORME

# THE EFFECTS OF INCREASING THE IODINE CONTENT OF THE TOMATO PLANT ON RESPIRATION AND ENZYMATIC ACTIVITY[1]

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## I. INTRODUCTION

Ever since its discovery in kelp by Courtois in 1811, iodine has been the subject of much biological research, and a truly enormous literature has developed. The greater number of studies deals with the relation of iodine to animal metabolism, especially to the activity of the thyroid gland. Even before its discovery in the thyroid glands by Baumann ('95), its connection with goitre was suspected, and Fourcault ('51 a, b), Thenard ('51), Chatin ('51–'53), Grange ('52), Casaseca ('53) and others had published their results on the relation of the iodine content of food, water, and air to the prevalence of human goitre and cretinism.

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[1] An investigation carried out in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

According to Muller (Lindley's 'The Vegetable Kingdom,' p. 353) iodine had been found in a cress of unknown origin. This fact was investigated and verified by Chatin ('50 a, b, '66), who may be considered the first to determine positively iodine in the higher plants. Since that time many questions have been raised concerning possible functions of iodine in the plant, but studies attacking these problems have been of little significance. The pertinent literature is so extensive that a satisfactory review can not be attempted here.

The unsatisfactory results of iodine research in plant physiology are perhaps due primarily to the lack of a successful method of growing plants free from iodine, and the absolute necessity of this element to growth is therefore almost impossible to demonstrate. Iodine is omnipresent in the air, according to Chatin ('51–'66), Gautier ('99, '20), and Wagner ('29), and also in water and soil, at least in minute traces. Even if the external experimental habitat were freed from iodine, the seed itself might pass on from generation to generation a biological sufficiency of this element.

The present paper reports the results of a study on tomato plants grown in water cultures to which various amounts of iodine as potassium iodide were added. The effects of the increasing amounts of iodine on growth, toxic symptoms, respiration, and enzymatic activity were observed.

Many workers have found that plants absorb iodine more or less proportionally to the amount present in the soil or culture solution. Stoklasa ('24) grew sugar beets in pots containing 12 kilograms of soil to which .02 gram iodine was added as potassium iodide, and found that in the air-dry tissue the controls contained .32 milligram iodine per kilogram of leaves, and .15 milligram per kilogram of roots, while the plants grown in the iodized pots contained .90 milligram iodine per kilogram of leaves and .60 milligram per kilogram of roots. Other researchers also have found an increase in iodine content on addition of this substance to the substrate, as Stoklasa ('26, '29, '30), Scharrer and Schwaibold ('27), Scharrer and Strobel ('27), Orr, Kelly, and Stuart ('28), Hiltner ('28). The field studies of Wrangell ('27) did not show any increase in iodine with iodine manuring, but as was later pointed out by Orr, Kelly, and Stuart ('28) this may have been due to some abnormal soil condition which made the iodine unavailable. It should be noted also that Klein ('27) in his critical review concluded that the iodine content of plants was held between narrow limits and that it was not possible to vary this significantly. In spite of these dissenting voices, it seems reasonable to conclude that the amount of iodine in plant tissues is dependent to a greater or less degree on the amount available in the substrate. Owing to the fact that all of the various enzymes discussed below were studied from a single lot of plants in order that the conditions of growth would be identical, sufficient tissue was not available for iodine analysis. The maximum possible number of plants was grown in the time permitted, and the tissue proportioned to the different phases of the work. Since the literature gives sufficient evidence concerning the absorption of iodine, all of the tissue available was reserved for the enzyme studies. The results reported below indicate definite physiological effects varying with the different concentrations of potassium iodide in the nutrient solution. This is in itself a proof that increasing amounts of iodide were absorbed. Kostytschew ('26) summarizes the situation as follows: "Es ist festgestellt, dass fermentative Oxydations- und Gärungsvorgänge durch Alkaloide und andere Reizstoffe ausserhalb der Zelle nicht gesteigert werden können. Nun ist auch eine Fermentbildung ausserhalb des lebenden Plasmas bisher nicht bekannt."

## II. GENERAL METHODS

"Bonny Best" tomato seed were planted February 27, 1932, in flats of greenhouse soil, and the seedlings were transplanted to the water culture jars on March 25. It is, of course, possible that during this month of contact with soil, sufficient iodine was absorbed to mask the effect of the later addition of small amounts to the water cultures. However, the purpose of the work was not to study the necessity of iodine in itself, nor to determine its optimum concentration for growth, but to observe the physiological effects of increasing the iodine content of the plant. Hence the possibility of the absorption of some iodine during this stage was disregarded, since all seedlings were germinated under identical conditions, in the same greenhouse flat.

The nutrient medium used was Shive's ('17) three-salt solution, which he found best for buckwheat tops. Its composition was as follows:

| | |
|---|---|
| $KH_2PO_4$ | .0144 M |
| $Ca(NO_3)_2$ | .0052 M |
| $MgSO_4$ | .0200 M |

One part per million of manganese as manganous sulphate, boron as sodium borate, and iron as ferrous sulphate were used in all cultures. Potassium iodide was added to give 1, 5, 10, and 20 parts per million of iodine. A control series contained no potassium iodide.

The cultures were grown in one-quart glazed earthenware jars. These were allowed to stand filled with 2N sodium hydroxide for two weeks and with 2N sulphuric acid for two weeks, so that all easily soluble substances would be dissolved from the surface. Sheets of cork six inches square and one-half inch thick covered the tops of the jars so that no light could reach the roots. Holes one-half inch in diameter were cut in the cork to accommodate the plants. Six plants were placed in each jar. During the first week the solutions were renewed twice, during the second week three times, and daily from then on.

## III. EXPERIMENTAL RESULTS

### A. GROWTH

The earliest worker dealing with the effect of iodine on the growth of plants was Suzuki ('02b). He grew *Pisum* in pots containing 2300 grams of air-dry soil plus .001 grain potassium iodide added six times during the growth period. The iodized soil was reported as causing the weight of fresh fruits to increase from 60.5 to 72.4 grams, the air-dry seed to increase from 23.2 to 26.3 grams, and the air-dry straw to increase from 10.7 to 15.5 grams. Since only one pot each was used for the control and experimental plants, and each pot contained only five plants, it is not possible to draw any positive conclusions from the experiment. The following year Susuki and Aso ('03) reported a stimulation of radish and oat seedlings in pot culture by the addition of potassium iodide. Here again the number of plants was too small to lend significance to the results.

Mazé ('15), noticing that corn grew well in sterile spring water but imperfectly or not at all in distilled water, set out to find the essential elements of the nutrition of this plant. The elements ordinarily present in nutrient solution did not give good growth. The addition of .004 grams of potassium iodide per liter showed a beneficial effect.

Budington ('19) observed the growth of onion root tips in 20 cc. of Pfeffer's nutrient solution to which .25 to 1 grain of desiccated thyroid gland was added. Only harmful effects on growth were noted, although when the same amounts of iodine were added as potassium iodide the growth was normal, from which it appears that the thyroid was harmful for some reason other than its iodine content.

Stoklasa ('24) found in pot studies that the addition of .02 gram of iodine as potassium iodide to 12 kilograms of soil produced a better development of sugar beets, especially of the leaves. In field studies 1.72 kilograms of iodine as potassium iodide per hectare gave a better growth of sugar beets and caused more and better seeds to develop during the second year. Stoklasa ('26) also found that .009–.015 gram of iodine as potassium iodide per 3200 cc. of nutrient solution increased the growth of *Hemerocallis fulva* almost 100 per cent. Potassium iodide at the rate of .021 gram of iodine per 12 kilograms of earth increased the growth of the leaves and roots of the sugar beets, confirming some earlier observations. Dafert and Brichta ('26), in comparing the value of synthetic nitrate with Chile saltpeter, found that iodine in an amount equal to that in the natural product had no effect on barley, mustard, and turnips. Brenchley ('24) found little or no beneficial effect of an iodine-potassium-iodide mixture on barley or mustard, but suggested that other plants might react differently. Wrangell ('27), using .3–1.5 kilograms of iodine as potassium iodine per hectare, grew a variety of agricultural plants, with no apparent effect on growth. Haas and Reed ('27) found that young orange trees did not thrive after 18–24 months unless the nutrient solution contained .2 part per million of I, Al, Ti, Br, Sr, Si, Mn, B, $NH_4$. It does not follow that each of these elements is necessary.

Scharrer and Schwartz ('27) found that small amounts of various inorganic iodine compounds slightly stimulated the multiplication of yeast, but did not increase the maximum yield. This work was followed by that of Greaves, Zobell, and Greaves ('28), who obtained poor growth on iodine-free nutrient solution and vigorous growth with 10 parts per million of iodine as potassium iodide. These authors held iodine to be an essential nutrient for yeast.

Engles ('28), through field studies on sugar beets and turnips, concluded that there was no stimulative effect from iodine added as potassium iodide. Stoklasa ('29) again reported a large increase in the growth of sugar beets from potassium iodide manuring. According to Haas ('30), iodine could be omitted from nutrient solutions for citrus plants with no harmful effect. Cotton ('30) found no stimulation to buckwheat growth in nutrient solutions containing concentrations of potassium iodide of 1.27 to 12.7 parts per million of iodine. Scharrer and Schropp ('31) observed a slight stimulation at low concentrations of iodine compounds on wheat in pot studies.

From this incomplete review of the literature it is apparent that no agreement has yet been reached concerning the effect of iodine on the growth of plants.

In the present work, only depressing effects on growth were observed. The average of 25 plants after a growth period of 2 months is represented in fig. 1, and the numerical data appear in tables I and II. From the curves it is seen that both the fresh and dry weight of the tops were about equally depressed. The dry weight of the roots was less depressed, and then only at the higher concentration. The degree of succulence as shown by the loss of weight on drying is apparently unaffected.

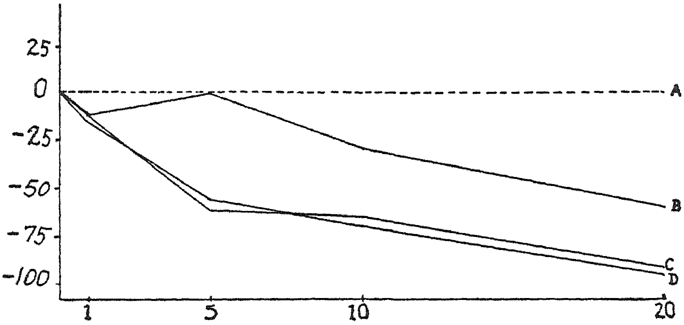


Fig. 1. Growth data: A, succulence (% of loss in drying); B, dry weight of roots; C, dry weight of tops; D, fresh weight of tops.

TABLE I

GROWTH DATA IN ABSOLUTE AMOUNTS. AVERAGE BASED ON 25 PLANTS. VALUES TAKEN ON APRIL 27, 1932, AFTER A GROWTH PERIOD OF 2 MONTHS

| Concentration of Iodine | Fresh wt. of tops (gms.) | Dry wt. of tops (gms.) | Dry wt. of roots (gms.) | Loss of wt. of tops in drying (gms.) | % of loss in tops by drying |
|---|---|---|---|---|---|
| Control | 9.4 | .84 | .28 | 8.56 | 91 |
| 1 p.p.m. | 8.7 | .78 | .26 | 7.92 | 91 |
| 5 p.p.m. | 6.8 | .59 | .28 | 6.21 | 91 |
| 10 p.p.m. | 6.2 | .57 | .24 | 5.63 | 91 |
| 20 p.p.m. | 5.0 | .46 | .20 | 4.54 | 91 |

TABLE II

SAME AS TABLE I, THE FIGURES INDICATING THE RELATIVE VALUES, UPON WHICH THE GRAPHS OF FIGURE 1 ARE BASED. THE CONTROL IN EACH CASE IS TAKEN AS 100

| Concentration of Iodine | Fresh wt. of tops | Dry wt. of tops | Dry wt. of roots | % of loss in tops by drying |
|---|---|---|---|---|
| Control | 100 | 100 | 100 | 100 |
| 1 p.p.m. | 92 | 93 | 93 | 100 |
| 5 p.p.m. | 72 | 70 | 100 | 100 |
| 10 p.p.m. | 66 | 68 | 85 | 100 |
| 20 p.p.m. | 53 | 55 | 71 | 100 |

## B. TOXIC SYMPTOMS

The evidence of injury due to toxic concentrations of iodine compounds has been described by Suzuki and Aso ('03) and by Mazé ('19). These authors observed brown spots on the foliage. Cotton ('30), in a paper dealing specifically with the toxic effects of iodine and nickel on buckwheat in water culture, verified these observations. She found the spots to be characteristic in aspect. Generally slightly sunken areas appeared first, often near the margins of the leaves. These became pale brown spots encircled by a darker brown, and the areas enlarged and coalesced. The petioles then turned brown at the base and the leaf dropped.

In the present work many hundreds of tomato plants were grown in concentrations of potassium iodide that were obviously toxic to the plant, but no brown spotting of the foliage was observed. At a concentration of 1 part per million of iodine as potassium iodide, there was no visible effect on the health of the plant. At 5 parts per million, only rarely did individual plants appear to be unhealthy. Concentrations of 10 and 20 parts per million usually gave plants unhealthy in appearance. Toxicity was first shown by a decrease in the intensity of the green color. This was followed by a definite chlorosis of the leaves, particularly of the lower. It is true that this chlorotic condition developed first in the tissue between the larger veins and later spread over the entire leaf, but strictly speaking these areas could not be defined as spots.

This difference is probably due to the specific reaction of tomato plants, although it is noted that Mazé worked with corn and Cotton worked with buckwheat, and both obtained a characteristic spotting of the leaves. The leaves of our plants were quickly dropped when the chlorotic condition was reached. No specific injury to the growing tips was noted.

### C. ACIDITY OF THE PRESS JUICE

Stoklasa ('26) grew *Senecio vulgaris* in pot culture, with the addition of 0.05 gram of iodine as potassium iodide to each 9.5 kilograms of soil. After 40 days the pH of the press juice was determined. The iodine-manured plants showed a conspicuous increase in pH over the controls. The same result was obtained with *Epilobium hirsutum* and with *Beta vulgaris*. This change in acidity he attributed to the breaking down of organic acids due to the iodine in the plant increasing the enzymatic decomposition of these substances.

Since Stoklasa attributed considerable importance to this decrease in acidity because it would tend to stimulate general enzymatic activity in the tissue, a careful study was made of this feature. The press juice from 10 plants was determined by the quinhydrone electrode for each concentration of iodine in the nutrient solution. No significant difference was observed, and the variation in enzymatic activity of the tomato plants described below must be attributed to some other action than the effect of the iodine on the acidity of the press juice.

### D. RESPIRATION

The effect of iodine and iodine compounds on animal respiration has been investigated by a number of authors. Macht and Hooker ('18) studied the action of iodide, bromide, and nitrate ions on the respiratory center of a small dog. Dog's blood was defibrinated and diluted with Locke's solution in which the usual sodium chloride was replaced by sodium iodide. This preparation was perfused into the carotid artery under such conditions that the profusate was practically isolated in the head region. It was found that the iodide ion, as well as the bromide ion, stimulated the respiratory rate, as shown by the deeper amplitude of the respiration curve. Stimulation of the respiratory center is equivalent to an increase in intracellular oxidation only in case its activity parallels the demand by the cells for oxygen.

Cameron and Carmichael ('20) found that continued small doses of desiccated thyroid fed to white rats caused, among other things, a hypertrophy of various organs due to an increased metabolic rate. Sodium iodide fed in amounts equaling the iodine of the thyroid up to 100 times as much did not produce this effect, which indicates that it is not iodine itself but a particular iodine compound which is the effective agent.

Hara ('23) found that injections of elementary iodine into the rat in amounts corresponding to 2 grams in man did not affect the metabolic rate, as shown by the comparative oxygen absorption.

Wickwire, Seager, and Burge ('28) observed the effect of various iodine compounds on the rate of sugar utilization by goldfish. Desiccated thyroid, thyroxin, clacidine, potassium iodide, and sodium iodide, respectively, were added to 100-cc. portions of .1 per cent dextrose in such amounts that each portion contained .55 milligram of iodine. Two goldfish were put in each solution. Air was bubbled through, and after 30 hours the sugar remaining in the solution was determined by the Benedict method. Only the desiccated thyroid had any effect. This substance caused an increase of 50 per cent in the sugar utilization over that of the control. These results agree with those of Cameron and Carmichael ('20) that it is not iodine in itself but a definite compound of iodine that stimulates metabolism. Wilhelmj and Boothby ('30) further verified the stimulatory effects of thyroxin on the basal metabolic rate.

Baker, Bacon, Lundy and Klein ('30) found that a thyroid extract injected intravenously in dogs caused a depression of the respiration rate, followed by an increase. The same result was obtained with extracts of kidney, suprarenal gland, liver, pancreas, duodenum, thymus, prostate, and muscle, and therefore nothing can be inferred concerning the actual effect of iodine. These authors held that the symptoms were not due to thyroxin nor to di-iodo-tyrosin, since none of these substances showed the same amount of iodine present in the tissue extracts.

The discussion of the relation between the function of the thyroid and metabolic activities, particularly in cases of human goitre, is too extensive to review here.

The influence of iodine and iodine compounds on the rate of plant respiration metabolism has been but little studied, in spite of the fact that the results obtained by the animal biologists suggests that this would be a fertile field for research.

Lieben and Lászlo ('25) investigated the effect of various ions on sugar metabolism of oxygenated yeast and found that the iodine ion, in common with several other ions, significantly increased the utilization of sugar although there appeared to be no relation between the quantity of these ions present and their effectiveness.

Stoklasa ('26) found that the roots of iodine-poor sugar beets produced 1463 milligrams $CO_2$ in a definite period, while iodine-rich roots eliminated 1522 milligrams during the same time. In anaerobic conditions and in a pure hydrogen atmosphere this increase did not occur. Comparable results were obtained with potato tubers. This author also held that iodine as potassium iodide in the nutrient medium of *Azotobacter chroococcum* stimulated respiration, and thereby increased the amount of nitrogen fixed during the process.

Greaves, Zobell and Greaves ('28) investigated the effects of iodine and iodine compounds on the rate of reproduction and carbon-dioxide output of yeast. Commercial yeast in the presence of 1 part per million of iodine as potassium iodide showed an increased growth, but the individual metabolic activity was not affected. Comparable results were obtained with sodium iodide, calcium iodide, and iodine. The metabolic activity was increased, however, by these substances in the presence of maltose or lactose.

Scharrer and Claus ('30) found that 9-hour cultures of beer yeast eliminated less $CO_2$ when .5 per cent iodine as sodium

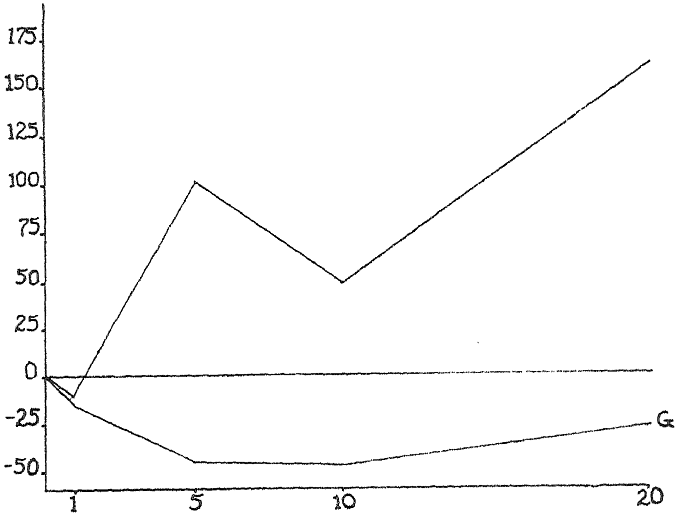


Fig. 2. Respiration Determination 1.

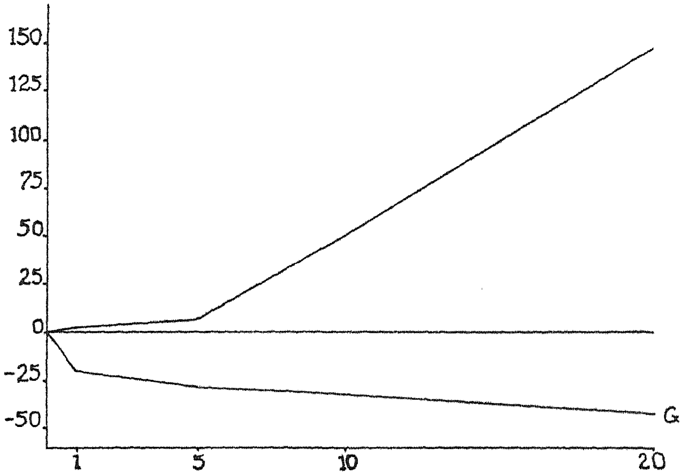


Fig. 3. Respiration Determination 2.

*Explanation of graphs.*—In all cases, the value of the control plant is calculated as 100, and the potassium-iodide-treated plants as per cents of the control. The numbers on the ordinate represent the per cent stimulation or depression, the graphical value of the control therefore being zero. The horizontal line divides the stimulation and depression values. The numbers on the abscissa represent the parts per million of iodine as potassium iodide in the nutrient solution. Curve "G" represents the growth of the plants used for the determinations indicated by the remaining curves of the same figure.

iodide was present in the culture medium, but with 2.02 per cent iodine there was a conspicuous increase.

As a part of the present investigation the carbon dioxide output from tomato plants growing in water culture was measured. In preliminary work it was found difficult to obtain thorough absorption of carbon dioxide by drawing air through liquid absorbents unless such a quantity of absorbents was used that accurate titration was impossible. Absorption bulbs so constructed that the air bubbles were broken several times gave complete absorption, but the absorbent was difficult to remove completely after each determination. Since liquid absorbents were either inaccurate or inconvenient, an apparatus involving a dry carbon-dioxide absorbent was designed. This has been previously reported by the author ('32), and is pictured in plate 17.

In each case, the nutrient solutions were renewed just before the determinations were started in order to eliminate the possibility of inaccuracy due to the activity of microorganisms. The culture jars, each containing from four to six plants, were placed in the bell-jar compartments of the respirometer at 10 o'clock in the evening, and the room was thoroughly darkened to eliminate photosynthetic activity during the early part of the succeeding morning. (For the details of the apparatus and of the procedure of determination, see Wynd, '32). At 8 or 9 o'clock the next morning, the Fleming-Martin absorption bulbs were disconnected and weighed on the analytical balance. The plants were then weighed and the carbon-dioxide elimination per gram of fresh weight of tops was calculated (tables III–IX). Since the relation between the extent of iodine injury and the increase in respiration is of some interest, detailed descriptions are given below.

### RESPIRATION DETERMINATION 1

Control—Plants normal in color and appearance.
1 p.p.m.—Plants indistinguishable from the controls.
5 p.p.m.—Plants showing slight injury; less green than the preceding; the lower leaves dropped.
10 p.p.m.—Indistinguishable from plants in the 5 p.p.m. solution.
20 p.p.m.—Indistinguishable from plants in the 5 p.p.m. solution.

Examination of table III and fig. 2 shows that the increase in respiration is not closely correlated with the extent of injury. Attention may be called to the fact that the plants growing in 20 p.p.m. of iodine showed even less injury as shown by the growth curves, than those in the two preceding concentrations, although their respiration was conspicuously higher.

TABLE III

RESPIRATION DETERMINATION 1, DATA TAKEN APRIL 18, 1932

| Iodine concentration | Number of plants | Average fresh wt. of tops (gms.) | Relative fresh wt. of tops (control as 100) | $CO_2$ output in 11 hrs. per gm. fresh wt. (gms.) | Relative $CO_2$ output per gm. fresh wt. (control as 100) |
|---|---|---|---|---|---|
| Control | 6 | 8.90 | 100 | .00321 | 100 |
| 1 p.p.m. | 6 | 7.54 | 85 | .00289 | 99 |
| 5 p.p.m. | 5 | 5.10 | 57 | .00637 | 199 |
| 10 p.p.m. | 6 | 4.87 | 55 | .00476 | 148 |
| 20 p.p.m. | 6 | 6.64 | 74 | .00842 | 262 |

RESPIRATION DETERMINATION 2

Control—Plants entirely normal in color and appearance.
1 p.p.m.—No visible toxic effect; plants entirely similar to the control.
5 p.p.m.—No visible toxic effect; plants entirely similar to the control.
10 p.p.m.—No visible toxic effect; plants entirely similar to the control.
20 p.p.m.—Plants less green, but decrease in color so slight as to be almost indetectable by the eye; a few of the lower leaves dropped.

Examination of table IV and fig. 3 shows that very little toxic effect was shown in this series. A small decrease in fresh weight occurred at 1 p.p.m., but no additional decrease oc-

TABLE IV

RESPIRATION DETERMINATION 2, DATA TAKEN APRIL 19, 1932

| Iodine concentration | Number of plants | Average fresh wt. of tops (gms.) | Relative fresh wt. of tops (control as 100) | $CO_2$ output in 10 hrs. per gm. fresh wt. (gms.) | Relative $CO_2$ output per gm. fresh wt. (control as 100) |
|---|---|---|---|---|---|
| Control | 6 | 10.3 | 100 | .00366 | 100 |
| 1 p.p.m. | 6 | 8.3 | 81 | .00374 | 102 |
| 5 p.p.m. | 5 | 7.4 | 72 | .00388 | 106 |
| 10 p.p.m. | 6 | 7.0 | 68 | .00543 | 149 |
| 20 p.p.m. | 6 | 6.0 | 58 | .00904 | 247 |

curred at the higher concentrations. Again there appears to be no striking connection between respiratory activity and degree of injury.

### RESPIRATION DETERMINATION 3

Control—Entirely normal plants.
1 p.p.m.—Entirely normal, indistinguishable from the controls.
5 p.p.m.—Entirely normal, indistinguishable from the controls.
10 p.p.m.—Lower leaves slightly yellowish.
20 p.p.m.—Entire foliage very slightly chlorotic.

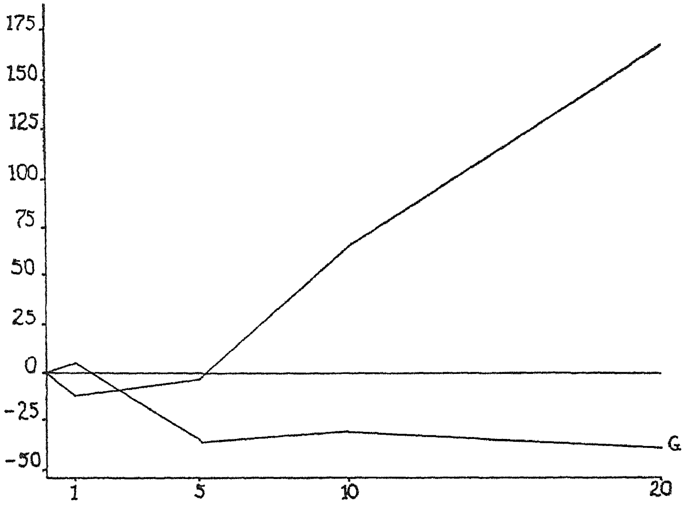


Fig. 4. Respiration Determination 3.

In this series, the 1 p.p.m. plants, while indistinguishable from the controls in appearance, weighed a little more. The data are given in table v and fig. 4. There is obviously no injury

### TABLE V

RESPIRATION DETERMINATION 3, DATA TAKEN APRIL 20, 1932

| Iodine concentration | Number of plants | Average fresh wt. of tops (gms.) | Relative fresh wt. of tops (control as 100) | $CO_2$ output in 10 hrs. per gm. fresh wt. (gms.) | Relative $CO_2$ output per gm. fresh wt. (control as 100) |
|---|---|---|---|---|---|
| Control | 6 | 9.5 | 100 | .00569 | 100 |
| 1 p.p.m. | 6 | 9.9 | 104 | .00455 | 89 |
| 5 p.p.m. | 6 | 6.4 | 67 | .00552 | 97 |
| 10 p.p.m. | 6 | 6.7 | 71 | .00924 | 164 |
| 20 p.p.m. | 5 | 6.1 | 63 | .01548 | 270 |

here, but again the respiration at this point is decreased. At higher concentrations, the increase of respiration was not proportional to the degree of visible injury nor to the decrease in weight. This is clearly shown in fig. 4.

### RESPIRATION DETERMINATION 4

Control—Plants entirely normal.
1 p.p.m.—Plants entirely normal, similar to the controls.
5 p.p.m.—Lower leaves slightly yellowish.
10 p.p.m.—Plants appearing identical to those in 5 p.p.m.
20 p.p.m.—Whole plant slightly less green than controls; lower leaves dropped.

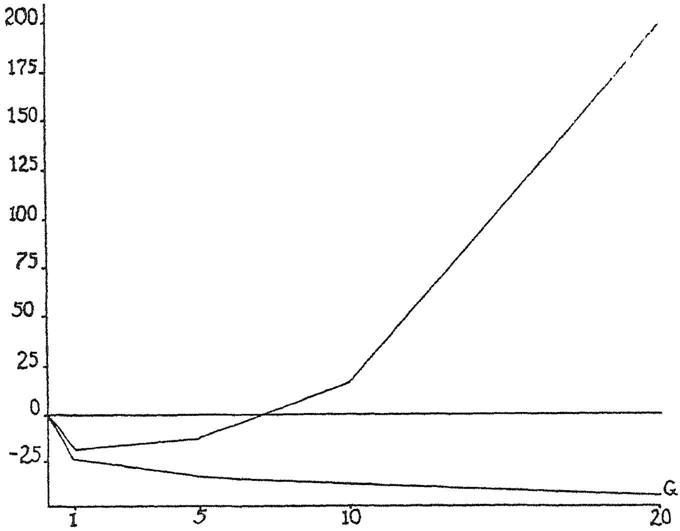


Fig. 5. Respiration Determination 4.

### TABLE VI

RESPIRATION DETERMINATION 4, DATA TAKEN APRIL 21, 1932

| Iodine concentration | Number of plants | Average fresh wt. of tops (gms.) | Relative fresh wt. of tops (control as 100) | $CO_2$ output in 10 hrs. per gm. fresh wt. (gms.) | Relative $CO_2$ output per gm. fresh wt. (control as 100) |
|---|---|---|---|---|---|
| Control | 6 | 9.2 | 100 | .00349 | 100 |
| 1 p.p.m. | 6 | 7.4 | 79 | .00278 | 80 |
| 5 p.p.m. | 6 | 6.4 | 68 | .00300 | 86 |
| 10 p.p.m. | 6 | 6.0 | 64 | .00403 | 116 |
| 20 p.p.m. | 5 | 3.7 | 39 | .01046 | 299 |

The plants of this series showed a more definite visible injury at the three higher concentrations than did any of the preceding series, although the respiration curve is entirely similar to that of determination 3, the plants of which showed almost no injury. The data are shown in table VI and fig. 5.

### RESPIRATION DETERMINATION 5

Control—Plants normal.
1 p.p.m.—Slightly less green than controls.
5 p.p.m.—Less green than the preceding; some lower leaves dropped.
10 p.p.m.—Less green than the preceding; more of the lower leaves dropped.
20 p.p.m.—Definitely chlorotic, and quite stunted; all lower leaves dropped.

The visible toxic symptoms do not correspond necessarily to the decrease in weight, as is shown by table VII and fig. 6.

TABLE VII

RESPIRATION DETERMINATION 5, DATA TAKEN APRIL 22, 1932

| Iodine concentration | Number of plants | Average fresh wt. of tops (gms.) | Relative fresh wt. of tops (control as 100) | $CO_2$ output in 10 hrs. per gm. fresh wt. (gms.) | Relative $CO_2$ output per gm. fresh wt. (control as 100) |
|---|---|---|---|---|---|
| Control | 6 | 8.2 | 100 | .00472 | 100 |
| 1 p.p.m. | 6 | 6.1 | 74 | .00450 | 95 |
| 5 p.p.m. | 5 | 6.6 | 80 | .00528 | 112 |
| 10 p.p.m. | 5 | 8.7 | 106 | .00580 | 123 |
| 20 p.p.m. | 4 | 3.3 | 40 | .01588 | 332 |

### RESPIRATION DETERMINATION 6

Control—Entirely normal.
1 p.p.m.—Entirely healthy and visibly larger than the controls.
5 p.p.m.—Lower leaves yellowish.
10 p.p.m.—Entire foliage yellowish; lower leaves dropped.
20 p.p.m.—More yellowish than the preceding, and more of the lower leaves gone.

Here, as in determination 3, the 1 p.p.m. plants were better than the controls, but the respiration at this point was lower as shown in table VIII and fig. 7.

The average of all determinations is represented in table IX and fig. 8. The absolute values given in the tables for the different sets of determinations are not strictly comparable. The conditions of the determinations varied as to temperature, length of the experimental period, and the relative degree of

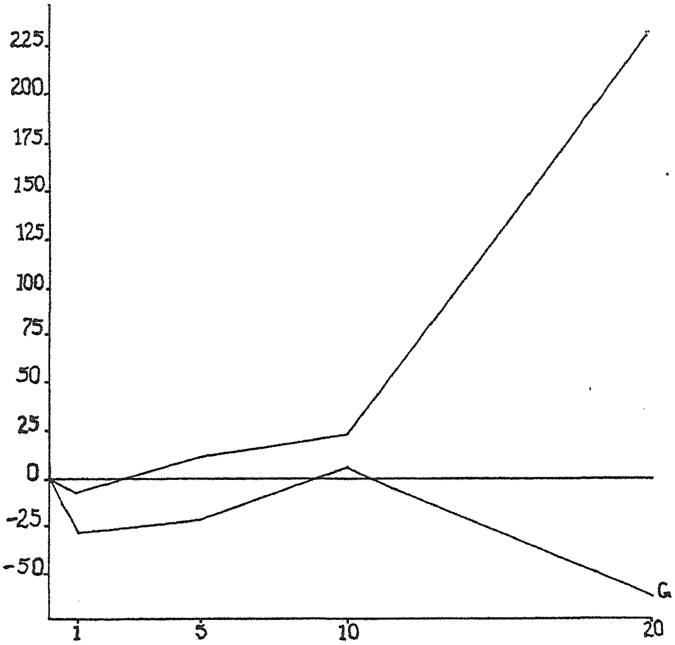


Fig. 6. Respiration Determination 5.

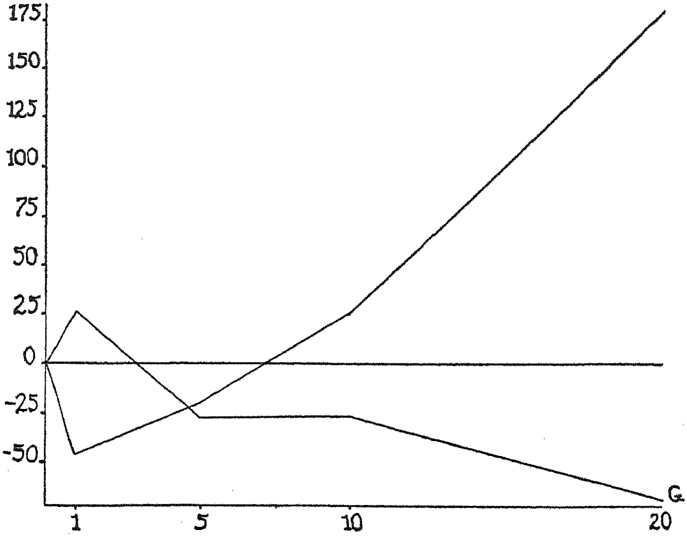


Fig. 7. Respiration Determination 6.

TABLE VIII

RESPIRATION DETERMINATION 6, DATA TAKEN APRIL 25, 1932

| Iodine concentration | Number of plants | Average fresh wt. of tops (gms.) | Relative fresh wt. of tops (control as 100) | $CO_2$ output in 11 hrs. per gm. fresh wt. (gms.) | Relative $CO_2$ output per gm. fresh wt. (control as 100) |
|---|---|---|---|---|---|
| Control | 6 | 9.1 | 100 | .00464 | 100 |
| 1 p.p.m. | 6 | 11.5 | 126 | .00246 | 53 |
| 5 p.p.m. | 5 | 6.9 | 75 | .00371 | 80 |
| 10 p.p.m. | 6 | 7.0 | 76 | .00596 | 128 |
| 20 p.p.m. | 5 | 3.2 | 35 | .01320 | 284 |

iodine injury. However, the conditions within any one set of determinations were identical since they were carried out simultaneously. It is for this reason that the graphs are drawn on the basis of the relative values within a given set. It is probably not justifiable to give absolute values for the averages of determinations under different conditions. The average of the relative values does give, however, a general picture of the reactions under the various sets of conditions.

TABLE IX

AVERAGE FOR ALL RESPIRATION DETERMINATIONS

| Iodine concentration | Number of plants averaged | Average fresh wt. of tops (gms.) | Relative fresh wt. of tops (control as 100) | Average $CO_2$ output in 10 hrs. per gm. fresh wt. (gms.) | Average relative $CO_2$ output per gm. fresh wt. (control as 100) |
|---|---|---|---|---|---|
| Control | 36 | 9.2 | 100 | .00424 | 100 |
| 1 p.p.m. | 36 | 8.4 | 91 | .00349 | 85 |
| 5 p.p.m. | 32 | 6.7 | 73 | .00463 | 113 |
| 10 p.p.m. | 35 | 6.7 | 73 | .00587 | 138 |
| 20 p.p.m. | 31 | 4.9 | 53 | .01208 | 282 |

The data obtained in this study show that at low concentrations of iodine (1 p.p.m. as potassium iodide) the respiratory activity, as represented by weight of carbon dioxide given off per gram of fresh weight over a definite time, is lowered. This lowering occurs independently of whether the plants do or do not show visible toxic effects. From this point there is a gradual recovery of normal respiratory activity which is usually reached at iodine concentrations of 5 to 10 p.p.m. The curve of the average in fig. 8 indicates that recovery occurs between 1 and 5 p.p.m., but this is because the average includes the erratic value represented in fig. 2 of determination 1. These results agree in general with those of Scharrer and Claus reported above.

Definitely *visible* toxic effects are evident only at the two higher concentrations, and these are the cultures showing the great increase in respiration. It should be noted, however, that the extent of the increase is not proportional to the degree of visible injury, and in some instances plants apparently healthy (although often not) show remarkable respiratory stimulation. It is also to be noted that this great increase, sometimes more than 300 per cent for the 20 p.p.m. plants, over that of the controls is a permanent respiratory level and is not the usual respiratory stimulation by toxic substances reported by many authors, which is of a temporary nature.

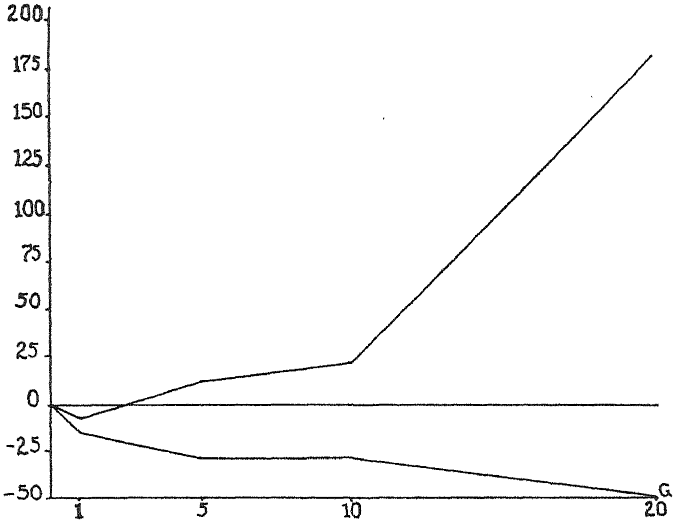


Fig. 8. Average of all respiration determinations.

Copeland ('03) found a close parallel between the toxicity of various metal ions and the expulsion of carbon dioxide from the cell. He points out that this may be due to the power of metallic ions to cause the decomposition of carbonate in the cell sap, and not therefore a stimulation of respiration. This interpretation is supported by the fact that these ions also cause an expulsion of carbon dioxide from tap water. Iodine and antipyrin did not evolve carbon dioxide from tap water, and therefore these substances may be assumed to stimulate the carbon dioxide evolution by an action on the protoplasm itself. This author mentioned that no poison has been found that does not stimulate carbon-dioxide production.

Irving ('11) reported that the proper concentration of chloroform would stimulate respiration of barley shoots and cherry laurel. Thoday ('13) also found that chloroform stimulated respiration and moreover that the absorption of oxygen kept apace with the increased carbon-dioxide production, and therefore he concluded that the respiratory process remained properly coordinated. This was found true only at the lower concentrations. A general review of the toxic substances stimulating respiration is too extended to include here, but attention should also be called to the work of Brooks ('18), Thomas ('18), and Ray ('23 a, b, c). There is general agreement that toxic substances stimulate carbon-dioxide evolution, and consequently we may not ascribe the great increase of carbon dioxide in our plants at the higher and obviously toxic concentrations as entirely due to any specific effect of iodine. However, the fact that the increase in respiration did not parallel the extent of injury does show that the iodine has some effect aside from the general stimulation by toxic substances. Whether our results conflict with those of Stoklasa cannot be decided at this time. He reports that the sugar beets used by him were stimulated in growth as well as in the respiratory activity of the roots, and if this be true the question of toxicity would not be a factor. It is entirely possible that different species of plants react differently.

## E. OXIDIZING ENZYMES

*1. Catalase.*—Issajew ('05) studied the effect of hydriodic acid, potassium iodide, and of elementary iodine on preparations of yeast catalase. A concentration of N/2000 hydriodic acid completely inhibited catalase, while potassium iodide at a concentration of N/10 depressed the reaction very slightly, if at all. Elementary iodine was completely inhibitory in a concentration of N/1152.

Juschtschenko ('11) removed the thyroid gland of dogs, and found that the blood catalase decreased, but if thyroid preparations were fed "per os" there was a recovery. It was found even possible to increase the catalase of the blood above the normal. The feeding of thyroid preparations to normal dogs, producing artificial hyperthyroidism, always caused an increase in blood catalase. When this feeding was discontinued, a normal condition was soon gained. Approximately the same results were obtained with rabbits. It is important to note that this author did not continue his observation of catalase activity in his test animals for a long enough time to show the effects of the accumulating amounts of iodine.

Strauss ('12) administered potassium iodide and sodium iodide to rabbits in amounts up to 4.0 grams per kilogram of body weight. The catalase activity was measured after 1, 4½, and 6 hours. The larger doses increased the catalase activity of the blood. This increase was ascribed to the effect of the iodides on the physiology of the organism rather than to any direct effect of these compounds in the blood.

Bach and Cheraskowa ('24) observed the activity of blood catalase of goats, 5 of which were normal animals and 7 had undergone thyroidectomy. Measurements were made daily for 10 days, but no difference between the two groups of animals was apparent.

The most extended study of this kind is that of Timofejewa ('27). *In vitro* studies of rabbits' blood showed that additions of potassium iodide were without effect, while a solution of iodine as potassium iodide, even at very low concentrations, lowered the catalase activity. Artificially prepared iodized proteins also exerted a depressing effect. Experiments with commercial thyroid were also performed. Subcutaneous injections of potassium iodide alone and of iodine dissolved in potassium iodide were given daily, and the blood samples were examined every 3 or 4 days. Both types of solutions showed a preliminary depression extending over a period of about 3 months, but this period was followed by a great increase in activity. Thyroid feeding also gave a curve of catalase activity similar to that of inorganic iodine except that the preliminary period of depression was of much shorter duration. This author concludes, from a comparison of the *in vitro* and *in vivo* experiments, that there is a relation between the thyroid function and the activity of blood catalase.

Although the function of catalase, particularly its connection with respiratory metabolism, has not been definitely determined, its very wide distribution in plant and animal tissues postulates its great importance in living processes.

In view of the results of the animal physiologists cited above, it seemed important to carry out *in vivo* experiments in the present study. The plants used were of the same series as those used for the respiration experiments. Catalase was determined on May 1, 1932, after the plants had been growing in the respective solutions for 37 days, by the potassium permanganate method (Waksman and Davison, '26). The upper half of the plant was cut into small pieces and ground to a paste with purified quartz sand. A pinch of powdered calcium carbonate was added to neutralize the organic acids. The paste was then squeezed through two thicknesses of cheesecloth, and 1 cc. of the liquid was added to the substate and allowed to incubate at room temperature for 3 hours.

TABLE X

CATALASE DETERMINATION 1

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | $H_2O_2$ decomposition of 1 cc. of sap | | | |
|---|---|---|---|---|---|---|
| | | | No buffer | | With buffer | |
| | | | Equivalents of $H_2O_2$ used up | Control as 100 | Equivalents of $H_2O_2$ used up | Control of "no buffer" as 100 |
| Control | 19.8 | 100 | .005336 | 100 | .006628 | 124 |
| 1 | 9.6 | .48 | .005306 | 99 | .005952 | 112 |
| 5 | 9.4 | .47 | .004502 | 84 | .005890 | 110 |
| 10 | 6.5 | .33 | .005888 | 110 | .006304 | 118 |
| 20 | 6.0 | .30 | .007060 | 149 | .008530 | 159 |

## TABLE XI

### CATALASE DETERMINATION 2

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | $H_2O_2$ decomposition of 1 cc. of sap | | | |
|---|---|---|---|---|---|---|
| | | | No buffer | | With buffer | |
| | | | Equivalents of $H_2O_2$ used up | Control as 100 | Equivalents of $H_2O_2$ used up | Control of "no buffer" as 100 |
| Control | 10.7 | 100 | .006424 | 100 | .007250 | 113 |
| 1 | 6.6 | 62 | .003700 | 58 | .002768 | 43 |
| 5 | 9.7 | 91 | .005090 | 79 | .005770 | 89 |
| 10 | 7.4 | 69 | .005638 | 88 | .006916 | 108 |
| 20 | 10.4 | 101 | .007444 | 116 | .008096 | 126 |

## TABLE XII

### CATALASE DETERMINATION 3

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | $H_2O_2$ decomposition by 1 cc. of sap | | | |
|---|---|---|---|---|---|---|
| | | | No buffer | | With buffer | |
| | | | Equivalents of $H_2O_2$ used up | Control as 100 | Equivalents of $H_2O_2$ used up | Control of "no buffer" as 100 |
| Control | 10.2 | 100 | .006420 | 100 | .006940 | 108 |
| 1 | 5.6 | 55 | .004880 | 76 | .005760 | 89 |
| 5 | 6.0 | 59 | .005658 | 88 | .006454 | 101 |
| 10 | 7.4 | 73 | .008778 | 137 | .009542 | 149 |
| 20 | 9.4 | 92 | .007700 | 119 | .008918 | 139 |

## TABLE XIII

### CATALASE DETERMINATION 4

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | $H_2O_2$ decomposed by 1 cc. of sap | | | |
|---|---|---|---|---|---|---|
| | | | No buffer | | With buffer | |
| | | | Equivalents of $H_2O_2$ used up | Control as 100 | Equivalents of $H_2O_2$ used up | Control of "no buffer" as 100 |
| Control | 10.0 | 100 | .007098 | 100 | .007894 | 111 |
| 1 | 19.1 | 191 | .005046 | 71 | .006012 | 85 |
| 5 | 8.4 | 84 | .005706 | 83 | .006610 | 93 |
| 10 | 8.0 | 80 | .006732 | 95 | .007730 | 109 |
| 20 | 8.3 | 83 | .008084 | 113 | .091600 | 129 |

Parallel determinations were made on two types of substrate, one being buffered at pH 7.0, the other with no buffer. The buffered substrate was prepared by adding .0100 equivalent of hydrogen peroxide to 40 cc. of distilled water, then 5 cc. of the buffer solution. The buffer consisted of 11.6 grams of potassium-di-hydrogen-phosphate and 24.9 grams of di-sodium-hydrogen-phosphate per liter. Five-cc. portions added to 45 cc. of the reacting mixture maintains a pH of about 7.0. The unbuffered substrate was the same except for the absence of the buffer. The reacting substances were shaken every few

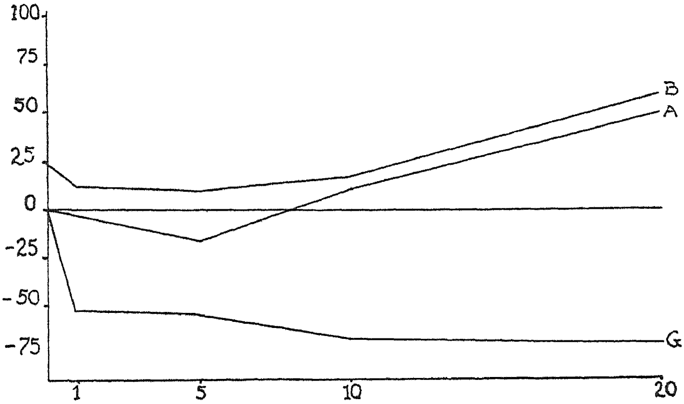


Fig. 9. Catalase Determination 1. A represents determinations on normal press juice; B, those in buffer.

TABLE XIV

AVERAGE OF ALL CATALASE DETERMINATIONS

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | $H_2O_2$ decomposed by 1 cc. of sap | | | |
|---|---|---|---|---|---|---|
| | | | No buffer | | With buffer | |
| | | | Equivalents of $H_2O_2$ used up | Control as 100 | Equivalents of $H_2O_2$ used up | Control of "no buffer" as 100 |
| Control | 12.6 | 100 | .006319 | 100 | .007178 | 114 |
| 1 | 10.2 | 81 | .004733 | 76 | .005123 | 82 |
| 5 | 8.4 | 67 | .005239 | 83 | .006181 | 98 |
| 10 | 7.3 | 58 | .006759 | 108 | .007623 | 121 |
| 20 | 8.5 | 68 | .007547 | 124 | .008676 | 138 |

minutes to insure thorough mixing. At the desired time, the reaction was stopped by adding 20 cc. of a 25 per cent sulphuric acid solution. Titration was carried out immediately with N/5 potassium permanganate.

The results (tables x-xiv and figs. 9–13 inclusive) show that the plants growing in the lower concentrations of potassium iodide exhibited a lower catalase activity of the sap than did the controls, but between 5 and 10 p.p.m. of iodine, normal activity was regained. The higher concentrations always produced plants with catalase activity conspicuously greater than the controls. These results agree with those of Timofejewa cited above. It should be noted that the preliminary drop and the subsequent rise does not seem to be proportional to the degree of iodine injury as shown by the fresh weight of tops.

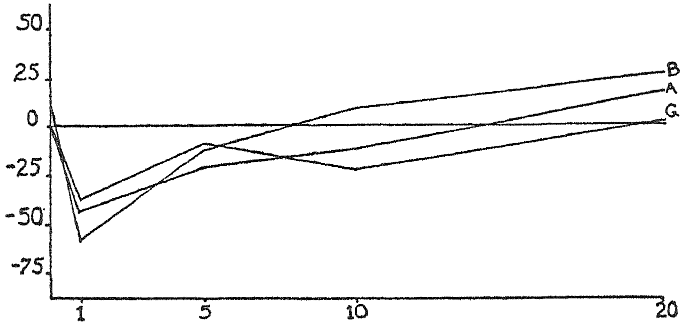


Fig. 10. Catalase Determination 2.

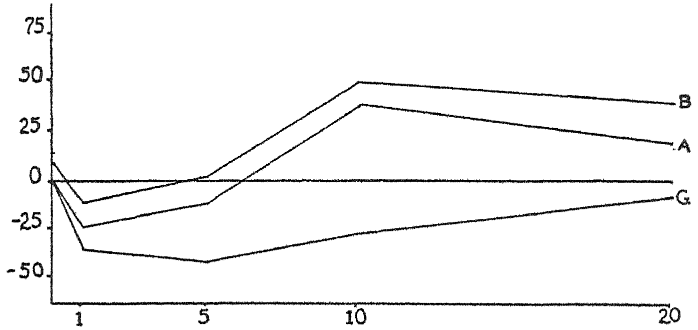


Fig. 11. Catalase Determination 3.

This is particularly noticeable in fig. 12, which shows the plant growing in 1 p.p.m. iodine as potassium iodide to be much larger than the control, yet this exceptional plant exhibited the preliminary drop just as did all the other plants growing in this type of solution.

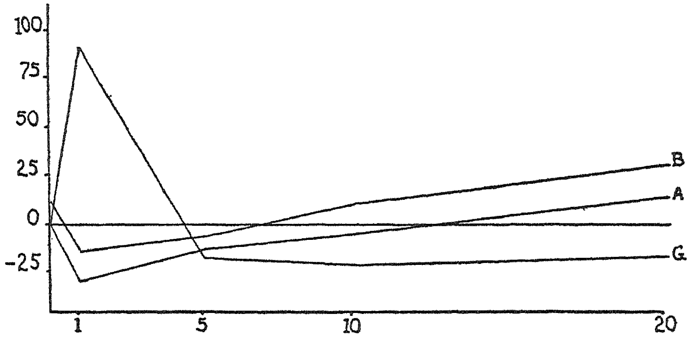


Fig. 12. Catalase Determination 4.

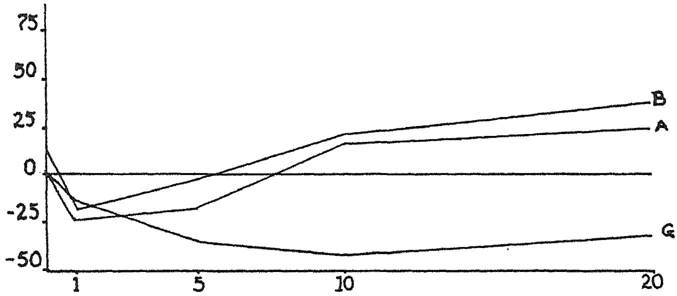


Fig. 13. Average of all catalase determinations.

2. *Peroxidase.*—The method of Guthrie ('31) was used to determine quantitatively peroxidase and oxidase. This author points out that the mixture of alpha-naphthol and paraphenylenediamine is oxidized far too rapidly for quantitative determination of these enzymes if the mixture is near neutrality, but if the reacting solution be buffered at pH 4.5, the rate of oxidation is sufficiently slow to allow accurate comparisons to be made. This acidity also inhibits catalase and prevents the interference of this enzyme.

The citrate buffer was made by dissolving 21 grams of crystalline citric acid in 170 cc. of normal sodium hydroxide, and diluting to 1 liter. The substrate was prepared as follows: to 200 cc. of the citrate buffer, 200 cc. of water was added, and then 1 gram of para-phenylenediamine hydrochloride and 20 cc. of a 4 per cent solution of alpha-naphthol in 50 per cent alcohol. This was filtered and used immediately.

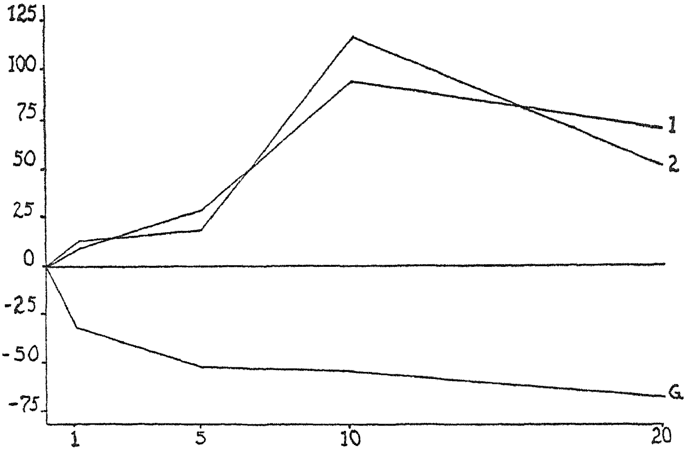


Fig. 14. Peroxidase Determination 1.

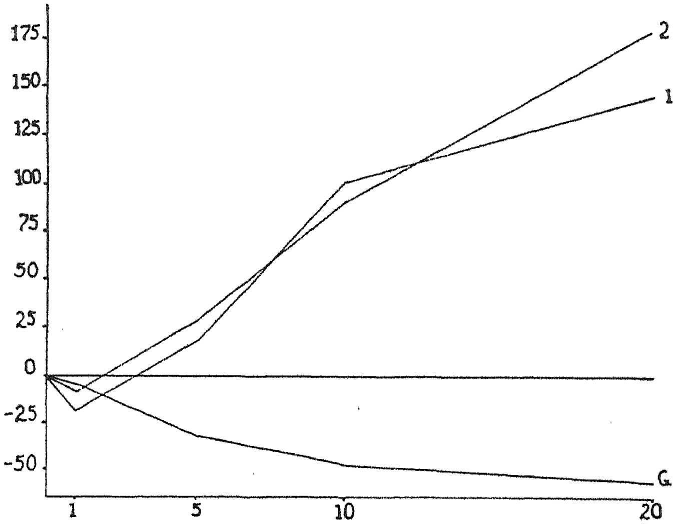


Fig. 15. Peroxidase Determination 2.

The upper portions of the plants were ground with purified quartz sand, and the mass squeezed through cheesecloth. Portions of 1 cc. were added to 25 cc. of the freshly prepared substrate. This was followed by the addition of 5 cc.

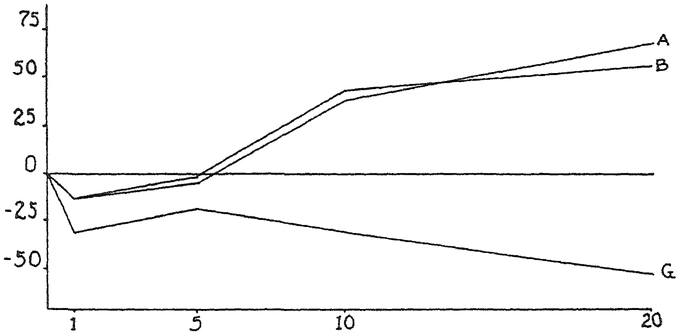


Fig. 16. Peroxidase Determination 3.

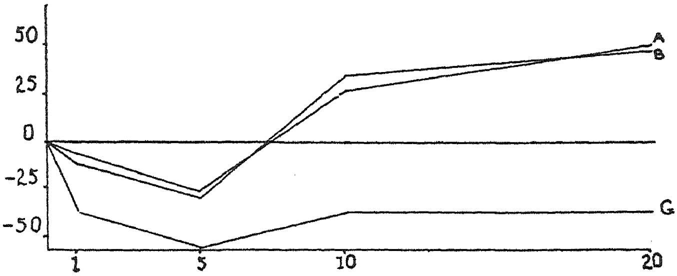


Fig. 17. Peroxidase Determination 4.

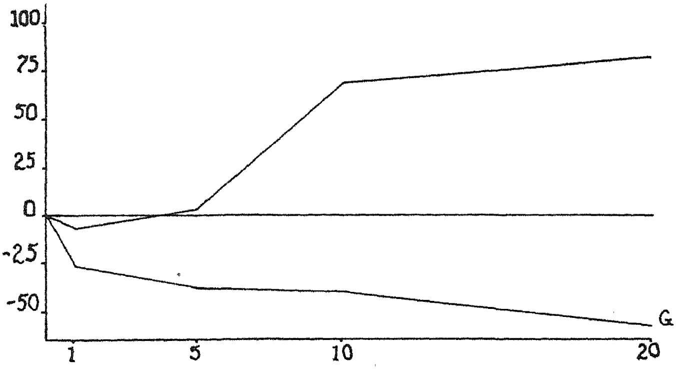


Fig. 18. Average of all peroxidase determinations.

of N/20 hydrogen peroxide. After 15 minutes the reaction was stopped by the addition of 5 cc. of a .1 per cent aqueous solution of potassium cyanide. Twenty-five cc. of toluene were then added and shaken vigorously until the water layer appeared colorless. The toluene, containing the indophenol,

TABLE XV

PEROXIDASE DETERMINATION 1

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | Relative peroxidase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 27.7 | 100 | 100 | 100 |
| 1 | 18.2 | 69 | 109 | 114 |
| 5 | 13.5 | 49 | 128 | 119 |
| 10 | 12.7 | 46 | 194 | 217 |
| 20 | 9.1 | 33 | 167 | 149 |

TABLE XVI

PEROXIDASE DETERMINATION 2

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | Relative peroxidase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 18.3 | 100 | 100 | 100 |
| 1 | 17.5 | 95 | 83 | 92 |
| 5 | 12.6 | 69 | 118 | 127 |
| 10 | 10.7 | 53 | 200 | 189 |
| 20 | 8.1 | 44 | 244 | 279 |

TABLE XVII

PEROXIDASE DETERMINATION 3

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | Relative peroxidase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 17.9 | 100 | 100 | 100 |
| 1 | 12.5 | 69 | 89 | 89 |
| 5 | 14.7 | 82 | 96 | 98 |
| 10 | 12.6 | 71 | 139 | 143 |
| 20 | 6.1 | 48 | 167 | 156 |

TABLE XVIII

PEROXIDASE DETERMINATION 4

| Iodine Concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | Relative peroxidase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 17.6 | 100 | 100 | 100 |
| 1 | 11.3 | 64 | 94 | 87 |
| 5 | 7.7 | 44 | 74 | 72 |
| 10 | 11.2 | 64 | 127 | 135 |
| 20 | 7.2 | 41 | 149 | 147 |

TABLE XIX

AVERAGE OF ALL PEROXIDASE DETERMINATIONS

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. (control as 100) | Relative peroxidase activity (control as 100) |
|---|---|---|---|
| Control | 20.4 | 100 | 100 |
| 1 | 14.9 | 74 | 95 |
| 5 | 12.1 | 61 | 105 |
| 10 | 11.8 | 59 | 168 |
| 20 | 7.6 | 42 | 182 |

was then poured off, centrifuged, and examined in a colorimeter. Samples from the entire series of plants were run simultaneously and in duplicate.

The oxidase determinations were carried out identically and simultaneously on the same samples of press juice, but with the omission of the hydrogen peroxide.

Since comparative results, rather than absolute amounts, were the object of the study, the intensity of color of the centrifuged toluene-indophenol solution obtained from the action of the sap of the control plants was taken as 100, and the other values calculated comparatively. The determinations were made on May 8, 1932, after the plants had grown in the respective solutions for 44 days.

The results are set forth in tables XV to XIX, and figs. 14 to 18 inclusive. Here again there is a preliminary period of depression, followed by a significant increase. A comparison of the growth curves with the enzyme curves shows that the increase of peroxidase activity is not proportional to the degree of injury by the toxic concentrations of potassium iodide. The curves do, however, closely parallel those of respiration.

*3. Oxygenase.*—The terms oxidase and oxygenase have been variously used in the literature. Bach and Chodat defined oxygenase as an organic peroxide. Kostytschew ('26) states that, "Die unbeständigen Substanzen vom Peroxydtypus führen den Namen Oxygenasen. Ihre chemische Natur ist bis jetzt unbekannt, doch sind sie allem Anschein nach organische Substanzen. Die reduzierten Oxygenasen, die den labilen Saurerstoff abgespalten haben, nennt man Oxydasen. Die Oxydasen gehen unter Sauerstoffaufnahme wieder in Oxygenasen über." Other authors have used oxidase to denote the oxygen-activating enzyme and oxygenase as the complex of oxidase plus the quinone-like substances produced by it. This complex has the ability to oxidize many substances and has therefore been loosely referred to as oxygenase. In the present work, the term oxygenase is defined as the enzymatic catalyst by which molecular oxygen is activated toward substances of the general catechol type.

As indicated above, the determinations of oxygenase activity were carried out like those of peroxidase except that hydrogen peroxide was omitted from the reaction mixture. Theoretically, this should be a satisfactory means of determining oxidase activity, but as has been pointed out by Onslow ('31), the problem is complicated as shown in the following paragraphs.

Szent-Györgyi ('25), in his study of oxidation mechanisms of the potato, determined that compounds of the ortho-quinone type were formed by the action of oxygenase on compounds having the ortho-dihydroxy-benzene grouping. These ortho-quinones are to be considered as the final product of the action of oxygenase itself. During this process, peroxide is formed: (1) either by the preliminary formation of organic (catechol) peroxides by a union with free oxygen of the air, and the subsequent breaking up to give hydrogen peroxide and some oxidation product of catechol; or (2) more directly by the transference of hydrogen from catechol compounds to molecular oxygen producing hydrogen peroxide and orthoquinone.

In the present oxygenase studies 1-cc. aliquots of the same expressed plant juice as used for the peroxidase determination were taken, and both enzymes determined simultaneously. Since peroxidase was present in large amounts, particularly in the plants grown in the higher potassium-iodide concentrations, there is no reason why the peroxide formed by oxygenase could not have initiated reactions giving the same oxidation products as the oxygenase. This is undoubtedly a source of error in the present work, since a part of the color developed (indo-phenol) came from this side reaction between peroxidase and the developing peroxide. If, however, these reactions seriously affected the results, we could expect the plant juice having the greatest peroxidase to give also the greatest apparent oxygenase reaction. From a comparison of the curves for these two enzymes it may be seen that this is not the case. The significance of this source of error is further lessened by the fact that some of the peroxide acted upon by peroxidase originated from the oxygenase reactions. For this reason it is seen that while more indo-phenol may have been formed, the increase was proportional to that of oxygenase activity, and the general shape of the curve would be the same.

The results of the present study are set forth in tables xx–xxiv, and figs. 19–23. While the individual curves vary considerably the average (fig. 23) shows a small but progressive decrease of oxygenase activity in the plants grown in the higher potassium iodide solutions. This is particularly significant since the source of error discussed above tends to push the curve up, rather than down. It should be emphasized again that aliquots of these *same samples* of press juice show simultaneously a great peroxidase increase.

Owing to the comparatively slight variation of the amount of oxygenase activity the question might be raised as to whether this enzyme was present at all, especially since no absolute values are given. Onslow ('21) has determined that only about 60 per cent of the higher green plants contain the catechol-oxygenase system. Tomato fruit is known, moreover, to contain no oxygenase. In the controls of the reagents alone, carried out simultaneously with the oxygenase determination, a little indo-phenol was developed through atmospheric oxidation, but in no case did this amount ever exceed 16 per cent of that found in the experimental solutions. Hence the presence of oxygenase in the vegetative portion is clearly

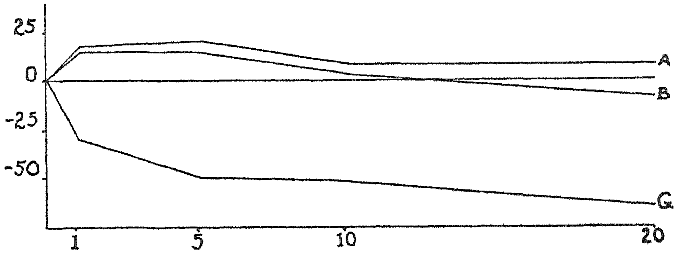


Fig. 19. Oxygenase Determination 1.

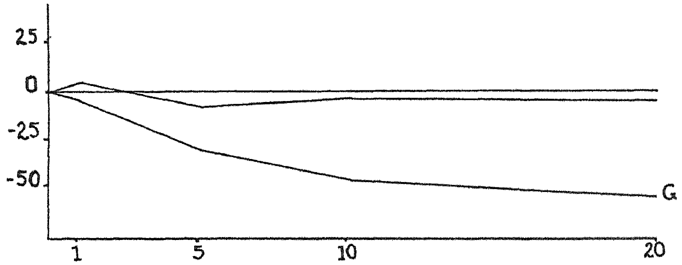


Fig. 20. Oxygenase Determination 2.

TABLE XX

OXYGENASE DETERMINATION 1, OF THE SAME PLANT JUICE AS PEROXIDASE DETERMINATION 1

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. of tops (control as 100) | Relative oxygenase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 27.7 | 100 | 100 | 100 |
| 1 | 18.2 | 69 | 118 | 115 |
| 5 | 13.5 | 49 | 121 | 115 |
| 10 | 12.7 | 46 | 108 | 102 |
| 20 | 9.1 | 33 | 107 | 91 |

TABLE XXI

OXYGENASE DETERMINATION 2, OF THE SAME PLANT JUICE AS PEROXIDASE DETERMINATION 2

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. of tops (control as 100) | Relative oxygenase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 18.3 | 100 | 100 | Determin. lost |
| 1 | 17.5 | 95 | 104 | Determin. lost |
| 5 | 12.6 | 69 | 92 | Determin. lost |
| 10 | 10.7 | 53 | 97 | Determin. lost |
| 20 | 8.1 | 44 | 94 | Determin. lost |

TABLE XXII

OXYGENASE DETERMINATION 3, OF THE SAME PLANT JUICE AS PEROXIDASE DETERMINATION 3

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. of tops (control as 100) | Relative oxygenase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 17.9 | 100 | 100 | 100 |
| 1 | 12.5 | 69 | 80 | 83 |
| 5 | 14.7 | 82 | 80 | 81 |
| 10 | 12.6 | 71 | 77 | 82 |
| 20 | 6.1 | 48 | 68 | 79 |

TABLE XXIII

OXYGENASE DETERMINATION 4, OF THE SAME PLANT JUICE AS PEROXIDASE DETERMINATION 4

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. of tops (control as 100) | Relative oxygenase activity | |
|---|---|---|---|---|
| | | | Determin. A (control as 100) | Determin. B (control as 100) |
| Control | 17.6 | 100 | 100 | 100 |
| 1 | 11.3 | 64 | 63 | 91 |
| 5 | 7.7 | 44 | 56 | 71 |
| 10 | 11.2 | 64 | 68 | 92 |
| 20 | 7.2 | 41 | 57 | 73 |

demonstrated. Bunzell ('16) also found oxygenase activity in the tomato plant. Two cc. of juice expressed from the leaves absorbed sufficient atmospheric oxygen to reduce the

TABLE XXIV

AVERAGE OF ALL OXYGENASE DETERMINATIONS

| Iodine concent. (p.p.m.) | Fresh wt. of tops (gms.) | Fresh wt. of tops (control as 100) | Relative oxygenase activity (control as 100) |
|---|---|---|---|
| Control | 20.4 | 100 | 100 |
| 1 | 14.9 | 74 | 93 |
| 5 | 12.1 | 61 | 88 |
| 10 | 11.8 | 59 | 89 |
| 20 | 7.6 | 42 | 56 |

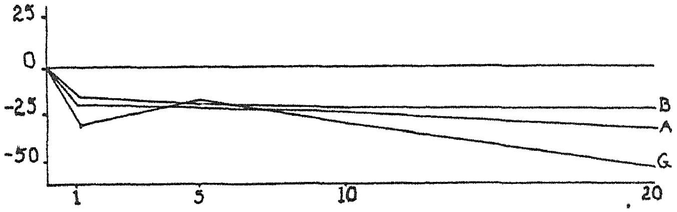


Fig. 21. Oxygenase Determination 3.

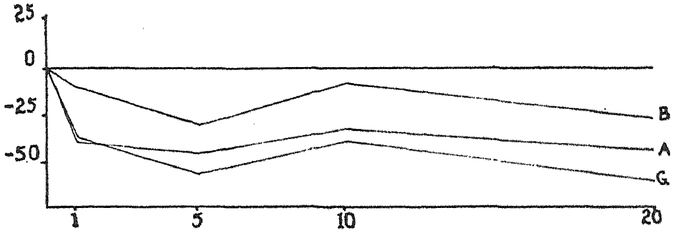


Fig. 22. Oxygenase Determination 4.

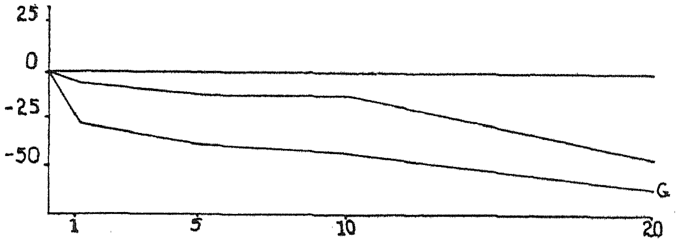


Fig. 23. Average of all oxygenase determinations.

pressure in his apparatus 1.10–1.60 mm. of mercury. The substrate used was of the catechol type, and could therefore give the indo-phenol reaction by the intermediate formation of quinones.

The significance of the oxygenase-catechol system in plants has been much discussed. Palladin's theory, that respiratory chromogens, e.g., catechol-oxygenase or similar systems, furnish a mechanism for respiratory oxidation, depends upon this enzyme. This position is materially weakened by the fact that in the tissues of only about one-half of the higher plant orders may such a system be recognized. However, Keilin ('29) held the respiratory function of such an oxidation mechanism to be conclusively proved for yeast and animal tissues. This author used the same reagents and approximately the same procedure that was used in the present work.

Onslow ('31) believes that an effective mechanism would be more universally distributed in tissues, and therefore the existence of the catechol-oxygenase system should be regarded as aside from the fundamental respiratory mechanism. This author also emphasized experimental results, which show that only plants containing the substrate, e.g., catechol or similar compounds, contain oxygenase; hence the real problem is that of the physiology of the formation of these substances rather than their connection with oxygenase.

A comparison of the respiratory with the oxygenase curves would indicate that there is no connection in the tomato plant between respiration activity as shown by carbon-dioxide output and this enzyme. On the other hand, the peroxidase curves do show such a relationship. The author therefore believes it logical to assume that respiration is being carried on in some manner entirely separate from the catechol-oxygenase system. It then follows that if the comparatively small decrease of oxygenase activity in the plants grown in solutions of higher concentrations of potassium iodide be considered significant, it must be assumed that the increasing iodine content of the tissue has interfered with the normal physiology of the production of the ortho-dihydroxy-benzene type of compounds. It is greatly regretted that the lack of sufficient tissue prevented an actual quantitative study of these substances.

### F. NON-OXIDIZING ENZYMES

*1. Invertase.*—The effect of iodine and potassium iodide on the activity of invertase has been carefully studied *in vitro*. Euler and Landergren ('22) were the first to attack this phase of iodine physiology. They added a solution containing .74 mgm. of elemental iodine and 1.50 mgms. of potassium iodide per cc. to their invertase preparation and held it at 17° C. for one hour. The preparation was then added to the sugar solution containing 4.8 gms. of sucrose and 2 per cent phosphate, giving a total volume of 60 cc. These authors found that the concentration of potassium iodide used (.01 M) did not materially inactivate the invertase. The relative inversion velocity was 58.7 per cent of the control when .07 mgm. of elemental iodine was present. The relative inversion velocity was 45.9 per cent of the control in the presence of 10 times (.74 mgm.) this amount of iodine, thus the decrease of invertase activity was small compared to the wide range of iodine concentrations. It was concluded that while invertase was sensitive to iodine, most of its activity remained stable, even with large amounts of this substance. Treatment with sodium-thio-sulphate did not reactivate the enzyme.

The work was continued by Euler and Josephson ('22, '23). They considered that the invertase formed an iodine-invertase compound and they attempted its isolation and also to complete its inactivation by a silver salt. They found that the degree of inactivation by iodine and potassium iodide mixture was dependent on the time during which the iodine acts on the enzyme, and called this the "incubation" time. Complete inactivation by iodine was accomplished by lengthening the period of incubation. It is not yet certain that the inactivation depends upon any stoichiometric relation. There is also the possibility that iodine catalyzes the inactivation and therefore does not appear as an end product. Hence it might inactivate a larger number of invertase molecules than would correspond to its own number of molecules. Their study of the reaction constant of the inactivation process tends to support this assumption. These workers also found that while increasing amounts of iodine did not inactivate the invertase beyond a certain point, if the incubation time were short, bromine water could obviously call forth any degree of inactivation more or less independent of the incubation time, the degree of inactivation depending upon the bromine content. In summing up their work, Euler and Josephson made the following statements concerning the relation of invertase to iodine:

1. Iodine poisoning is dependent upon the time of incubation.
2. Iodine appears to exert a stronger effect on invertase of high purity than does bromine.
3. One gram of iodine suffices, under the conditions used, to depress the activity of 20,000 grams of invertase, of an initial inversion power of If=230, to about one-half.
4. The 50 per cent inhibited enzymes show the same optimal pH as the control.
5. The 50 per cent inhibited enzyme is held to be an iodine-invertase compound which is also an enzyme but of lower inversion power.
6. Bromine and silver agree very closely in their ability to inactivate invertase, but do not agree with the iodine inactivation equivalent. This indicates a similarity of the reaction of invertase to silver and bromine, but a specific and different reaction to iodine.

The present investigation of the effect of potassium iodide upon the invertase activity was carried out *in vivo*. Tomato plants grown in nutrient solutions containing increasing amounts of potassium iodide were harvested after a growth period of 45 days. The tops were cut in small pieces and dried in absolute alcohol and washed in ether and then spread out to dry. The dried material was then ground to a fine powder. One gram of the dry powder was mixed with 100 cc. of distilled water and soaked 12 hours in the Kelvinator. Then 15 grams of commercial sucrose were added and the mixture incubated at 37° C. for 24–48 hours. After incubation, the mixture was filtered and 10-cc. aliquots analyzed for reducing sugars. To the 10-cc. aliquots 15 cc. distilled water and 30 cc. of Fehling's solution were added. The 5 solutions to be compared were simultaneously boiled 3 minutes in large test-tubes in the same beaker of water. This insured comparable conditions of reduction in the different types of plants, and since

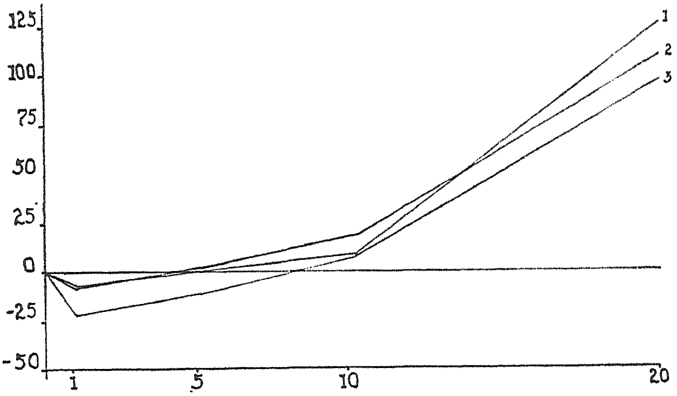


Fig. 24. Invertase Determination 1.

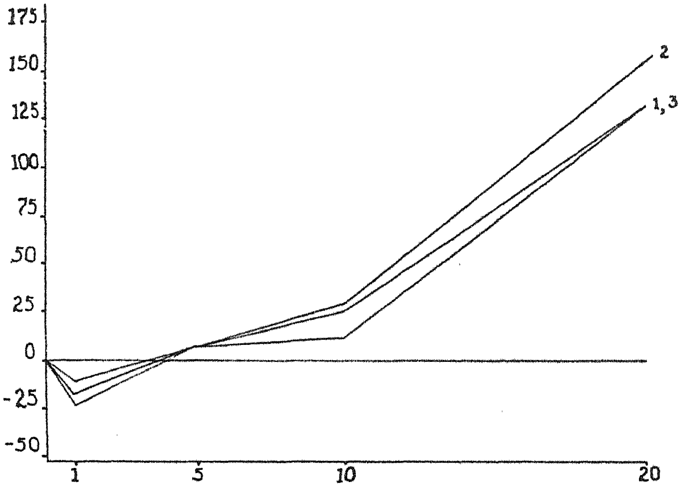


Fig. 25. Invertase Determination 2.

the final values are reported as per cent of the control, the absolute amount of reduction in any one series becomes unimportant. The copper oxide was immediately filtered off and dissolved in Bertrand's solution (20 per cent sulphuric acid which had been saturated with ferric-sulphate) as recommended by Morris and Wesp ('32). The amount of reduced iron in the acid solution was titrated with N/20 potassium permanganate.

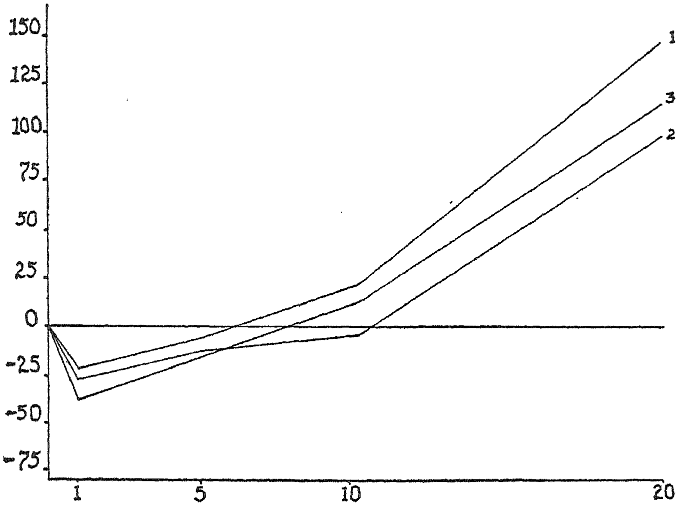


Fig. 26. Invertase Determination 3.

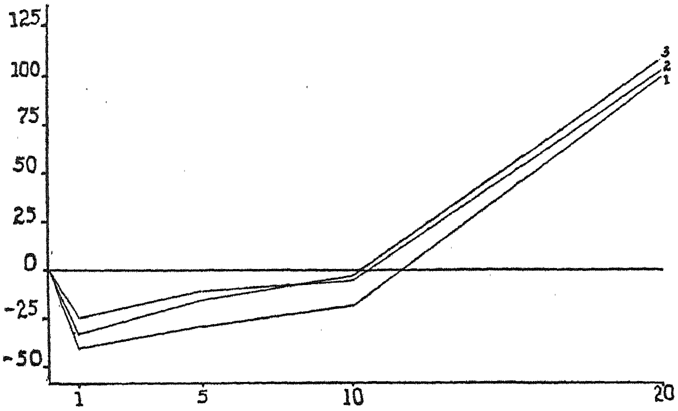


Fig. 27. Invertase Determination 4.

The number of cubic centimeters of permanganate used was taken as the basis for calculating the results comparatively. The results are shown in tables XXV–XXIX and in figs. 24–28. As is the case with the previous enzymes studied, with the exception of oxygenase, the preliminary period of depression is followed by a great increase. The effect of iodine in the previous *in vitro* studies is seen to be very different from the present *in vivo* experiments. This further supports the findings of Fuller ('32), who stated that enzymes behaved very differently toward ultra-violet radiation in his *in vivo* and *in vitro* studies.

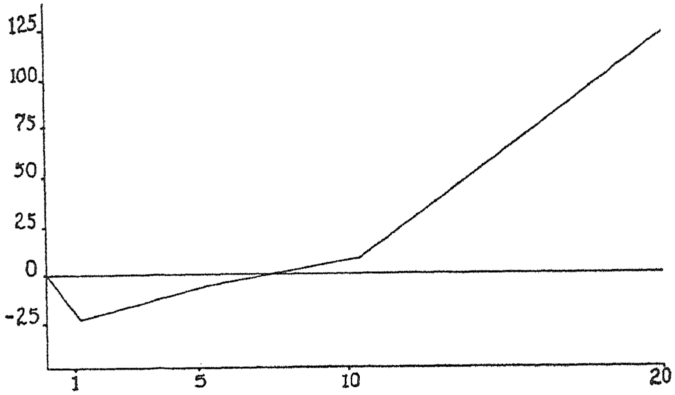


Fig. 28. Average of all invertase determinations.

Onslow ('31) reviews the literature dealing with the substrate for respiration in the higher green plants. In studies made on the change of carbohydrate fractions of respiring organs she noted that a hexose sugar is the substrate for respiration, and further, that fructose from sucrose hydrolysis

TABLE XXV

INVERTASE DETERMINATION 1, INCUBATION PERIOD 24 HOURS

| Iodine concent. in p.p.m. | cc. $KMnO_4$ used | | | | Relative amt. $KMnO_4$ used (control as 100) | | | |
|---|---|---|---|---|---|---|---|---|
| | Set 1 | Set 2 | Set 3 | Ave. | Set 1 | Set 2 | Set 3 | Ave. |
| Control | 7.61 | 9.17 | 8.58 | 8.45 | 100 | 100 | 100 | 100 |
| 1 | 6.98 | 8.56 | 6.73 | 7.42 | 92 | 93 | 78 | 88 |
| 5 | 7.67 | 9.22 | 7.70 | 8.20 | 101 | 101 | 89 | 97 |
| 10 | 8.22 | 10.82 | 9.15 | 9.40 | 108 | 118 | 107 | 111 |
| 20 | 17.20 | 19.16 | 17.02 | 17.79 | 226 | 209 | 198 | 210 |

### TABLE XXVI

INVERTASE DETERMINATION 2, INCUBATION PERIOD 24 HOURS

| Iodine concent. in p.p.m. | cc. KMnO$_4$ used | | | | Relative amt. KMnO$_4$ used (control as 100) | | | |
|---|---|---|---|---|---|---|---|---|
| | Set 1 | Set 2 | Set 3 | Ave. | Set 1 | Set 2 | Set 3 | Ave. |
| Control | 10.92 | 10.45 | 9.22 | 10.20 | 100 | 100 | 100 | 100 |
| 1 | 8.30 | 8.54 | 8.25 | 8.36 | 76 | 82 | 89 | 82 |
| 5 | 11.66 | 11.21 | 9.92 | 10.93 | 107 | 107 | 107 | 107 |
| 10 | 12.07 | 13.16 | 12.05 | 12.43 | 111 | 125 | 129 | 122 |
| 20 | 25.57 | 26.72 | 21.61 | 24.63 | 234 | 255 | 234 | 241 |

### TABLE XXVII

INVERTASE DETERMINATION 3, INCUBATION PERIOD 40 HOURS

| Iodine concent. in p.p.m. | cc. KMnO$_4$ used | | | | Relative amt. KMnO$_4$ used (control as 100) | | | |
|---|---|---|---|---|---|---|---|---|
| | Set 1 | Set 2 | Set 3 | Ave. | Set 1 | Set 2 | Set 3 | Ave. |
| Control | 12.28 | 17.27 | 14.46 | 14.67 | 100 | 100 | 100 | 100 |
| 1 | 9.46 | 12.59 | 9.05 | 10.37 | 77 | 73 | 62 | 71 |
| 5 | 11.71 | 15.04 | 12.54 | 13.10 | 95 | 87 | 86 | 89 |
| 10 | 15.08 | 16.67 | 16.72 | 16.16 | 123 | 97 | 115 | 112 |
| 20 | 30.89 | 35.12 | 31.68 | 32.56 | 251 | 203 | 219 | 224 |

### TABLE XXVIII

INVERTASE DETERMINATION 4, INCUBATION PERIOD 48 HOURS

| Iodine concent. in p.p.m. | cc. KMnO$_4$ used | | | | Relative amt. KMnO$_4$ used (control as 100) | | | |
|---|---|---|---|---|---|---|---|---|
| | Set 1 | Set 2 | Set 3 | Ave. | Set 1 | Set 2 | Set 3 | Ave. |
| Control | 15.14 | 17.05 | 14.80 | 15.69 | 100 | 100 | 100 | 100 |
| 1 | 8.78 | 12.85 | 9.69 | 10.44 | 58 | 75 | 65 | 66 |
| 5 | 10.56 | 15.30 | 12.51 | 12.79 | 69 | 89 | 84 | 81 |
| 10 | 11.24 | 16.16 | 13.36 | 13.56 | 81 | 95 | 89 | 88 |
| 20 | 30.38 | 34.70 | 30.89 | 31.79 | 201 | 203 | 208 | 204 |

is preferentially used. Should this fructose be exhausted, the more stable glucose may be utilized. To quote only one of many available studies concerning this problem, Evans ('28) found 80 per cent of the total hexose in stored apples to be glucose, the fructose from disaccharide hydrolysis having been depleted through respiration.

TABLE XXIX

AVERAGE OF ALL INVERTASE DETERMINATIONS, THE CONTROL TAKEN AS 100

| Iodine concent. in p.p.m. | Relative invertase activity |
|---|---|
| Control | 100 |
| 1 | 77 |
| 5 | 94 |
| 10 | 108 |
| 20 | 220 |

Since it is well authenticated that a hexose sugar serves as the respiratory substrate, it is to be expected that a conspicuous increase in invertase activity would accompany accelerated respiration. This is based on the concept discussed later that sucrose normally predominates over hexose in the tomato plant. Wehmer ('31) summarizes the analytical results of many publications concerning the sugar content of the fruit. The total sugar has been variously reported as being 3–5 per cent of the fresh weight. Sucrose has been reported as being about 1.7 per cent, levulose 1.12 per cent and glucose 1.12 per cent. Unfortunately, no published analyses have come to our notice concerning the carbohydrate fractions of the vegetative tissue.

*2. Peptase.*—Peptase, being a plant enzyme not directly concerned with the respiratory process, was used in order to determine whether iodine would affect it differently from those involving respiratory metabolism. The method of procedure was that of Fisher ('19) The number of free carboxyl groups was estimated by the method of Sörensen ('08).

The plants were grown in the culture solutions for 43 days. The tops were then shredded and dried by alcohol and washed with acetone as described for the material used for the invertase determinations. One gm. of dry plant powder was added to 200 cc. of a 2 per cent Witte peptone solution, and the mixture plus a little toluol was incubated for 4 days at 37° C. After that time, the material was filtered and the residue washed until the filtrate came to 400 cc. The filtrate was decolorized by shaking with alumina cream. Aliquots of 40 cc. of the prepared solution were titrated in the following manner. First, 15 cc. of a formaldehyde mixture were added. This solution was made by mixing 50 cc. of commercial formalin (40 per cent) with 25 cc. of absolute alcohol, and then adding 10 cc. of indicator. The indicator was prepared by dissolving .50 gram of Grubler's thymol-phthalein in 1000 cc. of 93 per cent alcohol. The free amino groups of the liberated amino acids react as a base, thereby masking the carboxyl groups. Hence formaldehyde is used to neutralize those groups by the formation of methylene compounds. The free carboxyl groups were then titrated by N/5 barium hydroxide.

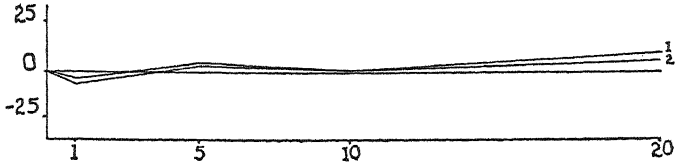


Fig. 29. Peptase determinations.

The number of cubic centimeters of hydroxide used is taken as the basis for comparison. The results are shown in tables xxx and xxxi and in fig. 29. The figure shows a very small preliminary drop, followed by a very small rise in peptoclastic activity. It is probable that these changes are not significant in view of possible inaccuracies of the method.

TABLE XXX

PEPTASE DETERMINATION 1

| Iodine conc. in p.p.m. | cc. Ba(OH)$_2$ used | | | | Comparative amount Ba(OH)$_2$ used (control as 100) | | | |
|---|---|---|---|---|---|---|---|---|
| | Titrat. 1 | Titrat. 2 | Titrat. 3 | Ave. | Titrat. 1 | Titrat. 2 | Titrat. 3 | Ave. |
| Control | 10.5 | 10.7 | 10.7 | 10.6 | 100 | 100 | 100 | 100 |
| 1 | 10.0 | 9.9 | 10.1 | 10.0 | 95 | 92 | 94 | 94 |
| 5 | 10.8 | 11.0 | 10.9 | 10.9 | 103 | 104 | 102 | 103 |
| 10 | 10.3 | 10.7 | 10.7 | 10.6 | 98 | 100 | 100 | 100 |
| 20 | 11.5 | 11.7 | 11.7 | 11.6 | 109 | 109 | 109 | 109 |

TABLE XXXI

PEPTASE DETERMINATION 2

| Iodine conc. in p.p.m. | cc. $Ba(OH)_2$ used | | | | Comparative amount $Ba(OH)_2$ used (control as 100) | | | |
|---|---|---|---|---|---|---|---|---|
| | Titrat. 1 | Titrat. 2 | Titrat. 3 | Ave. | Titrat. 1 | Titrat. 2 | Titrat. 3 | Ave. |
| Control | 11.4 | 10.4 | 10.2 | 10.7 | 100 | 100 | 100 | 100 |
| 1 | 10.7 | 10.0 | 9.9 | 10.3 | 94 | 96 | 97 | 96 |
| 5 | 10.9 | 11.2 | 11.3 | 11.1 | 96 | 108 | 111 | 104 |
| 10 | 11.0 | 10.6 | 10.5 | 10.7 | 97 | 102 | 103 | 100 |
| 20 | 11.2 | 11.0 | 11.5 | 11.2 | 98 | 106 | 112 | 105 |

## IV. THE RELATIONSHIPS BETWEEN OXYGENASE, PEROXIDASE, INVERTASE, AND CATALASE

### A. RESPIRATORY PIGMENTS

The theory of the function of respiratory pigments has been elaborated at some length by Palladin ('08–'12), Palladin and Lwow ('13), and by Palladin and Tolstoi ('13). These workers considered that respiratory pigments accept hydrogen from biologically oxidizable material and transfer it to the oxygen of the air, the pigments thereby becoming reduced to chromogens. This theory would regard biological oxidation as essentially a dehydrogenation process. Other students of respiratory mechanism have placed a varying degree of importance on this interpretation. Bach, Thunberg, and Wieland each regard the transfer of hydrogen of great significance. Several specific carriers of hydrogen have been identified from time to time. The glutathione of Hopkins ('21 a, b), the cytochrome of Keilin ('29), the hexuronic acid of Szent-Györgyi ('31), and the blue pigment found in *Bacillus pyocyaneus* by Friedheim ('31) are examples.

The fact that methylene blue has been found by many workers to stimulate metabolism is evidence of the importance of a dehydrogenating system for respiration. Warburg, Kubowitz and Christian ('30 a, b) have determined the mechanism by which methylene blue accelerates respiration. They interpret the reaction by arranging the following three equations:

Methylene blue + n-hemoglobin + $nH_2O$ → leuco methylene blue + n-methemoglobin.
n-methemoglobin + glucose → n-hemoglobin + glucose oxidation products + $nH_2O$.
Leuco methylene blue + $H_2O_2$ → methylene blue + $H_2O$.

These authors did not determine whether the sugar entered the reaction as glucose, phosphoric esters, or as some hexose cleavage product. The final reaction by which the leuco compound is oxidized to the colored state is defined as a "balancing" reaction, running parallel to the cellular catalytic processes, but the actual oxidation of the carbohydrate is accomplished by hemin iron.

Eddy ('31) found that intravenous injections of methylene blue increased the oxygen uptake of the organism.

### B. OBJECTIONS TO THE DEHYDROGENATION THEORY OF BIOLOGICAL OXIDATION

The chemical reactions by which hydrogen may be removed from oxidizable materials appear to depend upon the action of enzymes, at least in most instances. The relation between respirational reaction and enzymes has been seriously questioned by some workers. Engler and Herzog ('09) maintain that the importance of enzymes in biological respiration is greatly overrated.

The fact that oxygenase and peroxidase catalyze only the reactions which account for the formation of water by the union of atmospheric oxygen and derived hydrogen and do not break carbon chains, is a serious objection to a close association of these enzymes with respiration. At least this would tend to place the oxidizing enzymes in some subsidiary relation to a breaking of the carbon chain. Bertrand ('96), Portier ('97), and Porodko ('04) placed so much importance on the fact that oxidizing enzymes could not unite oxygen to carbon to form carbon dioxide that they denied that these enzymes could attack any important respirational substrate to be found in tissue.

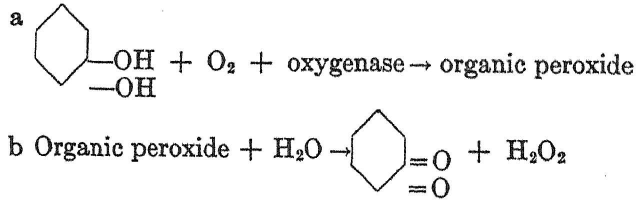
However, the case for oxidizing enzymes has been materially strengthened by the work of Lyon ('23, '27). This worker found that an aqueous extract of oxidase from potato tubers in the presence of sodium or potassium phosphate would slowly oxidize glucose or fructose with the liberation of carbon dioxide. The phosphate ion apparently acted as an intensifier of the oxidase. Wurmser ('32) aptly points out the probability of a dehydrogenating system coexisting with some system capable of breaking carbon chains.

### C. CHEMICAL REACTIONS OF THE OXIDATION MECHANISM STUDIED IN THE PRESENT WORK

As pointed out above, the experimental substrate for the determinations of peroxidase and oxygenase consisted of a mixture of para-dimethyl-phenylene-diamine-hydrochloride and alpha-naphthol in an alcoholic solution. This differs from the original "Nadi" reagent in that it was buffered at a higher acidity to suppress the action of catalase and to slow down the rate of oxidation.

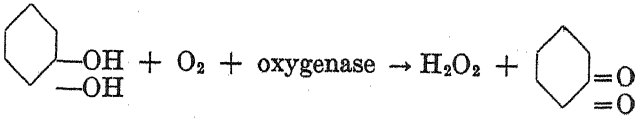
The steps of the reaction may be pictured as follows. The resulting quinone is to be considered as the final oxidation product of oxygenase itself. The reaction mixture may be assumed to contain compounds of the orthodihydroxy type since Onslow ('31) found these substances always present in plants exhibiting oxygenase activity.

1.


a
—OH + O₂ + oxygenase → organic peroxide
—OH
b Organic peroxide + H₂O →
=O + H₂O₂
=O

Or the initial step may form $H_2O_2$ directly:

2.

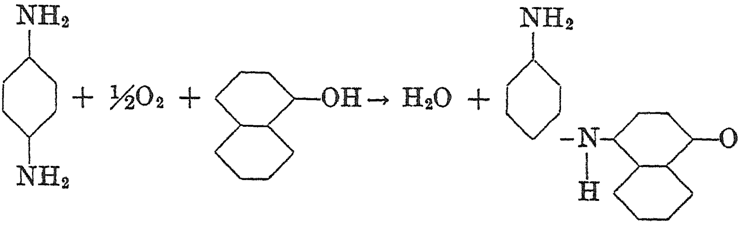


The quinone reacts upon the artificial substrate, forming the colored product.

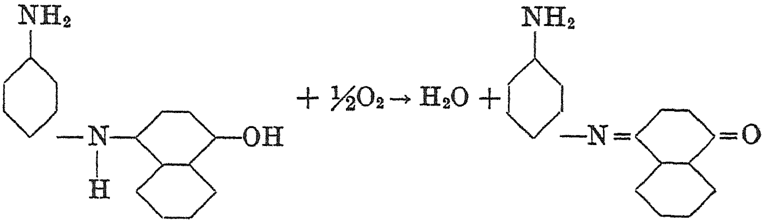
The indo-phenol may be considered as an artificial hydrogen acceptor. Such a compound in living tissue accepts hydrogen from the respirational substrate by the action of the dyhydrases.

Equations 3a, b, are those postulated by Rohmann and Spitzer ('95).

3. a

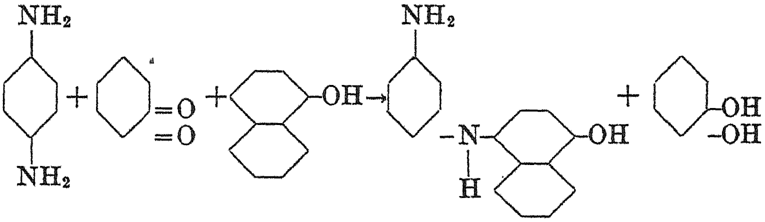


b



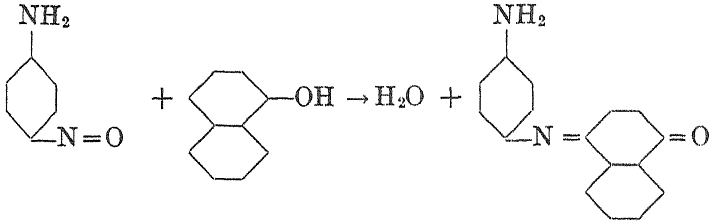
If quinone be considered as the final product of oxygenase, equation 3a would be modified as follows:

c



Since equation 3b is not dependent upon enzymatic catalysis, the leuco compound formed in 3c would autoxidize in the presence of atmospheric oxygen independently of quinone. It is not impossible that the para-phenylene-diamine might become oxidized to the nitroso stage, in which case it would condense with the α-naphthol to give the colored indo-phenol as follows:

4.



Keilin ('29) distinguishes between his indo-phenol oxidase and the catechol oxidase of other workers. He describes indo-phenol oxidase as being insoluble, while catechol oxidase is soluble in water. They are both inhibited by potassium cyanide, hydrogen sulphide, and by carbon monoxide. Catechol oxidase is more sensitive to the inhibitory effect of carbon monoxide than indo-phenol oxidase. The catechol oxidase was described by him as having "all the essential properties of a typical oxidase."

It does not seem possible or necessary to separate these two oxidases in a discussion of the function of oxygen-activating enzymes in their relation to respiration. Any essential difference between these substances depends upon the assumption that indo-phenol oxidase oxidizes directly the aromatic amino groups of para-phenylene diamine or the leuco form of indo-phenol by the activation of atmospheric oxygen, while catechol oxidase acts only upon poly-hydroxy-benzene compounds, producing quinones, which then oxidize the leuco-indo-phenol or some naturally occurring chromogen. Keilin states that catechol oxidase will give the indo-phenol test in the presence of catechol compounds. According to Onslow ('31), this oxidase occurs only with the simultaneous occurrence of this substrate. Hence it is evident that the catechol oxidase in tissue preparations will always give the indo-phenol reaction unless great care has been used to remove all traces of polyphenolic compounds. On the other hand, in order to maintain the separate identity of these enzymes, it would be necessary to establish the fact that indo-phenol oxidase acts upon leuco indo-phenol or similar naturally occurring chromogens without the intermediate cooperation of such substances as the quinones.

This would be difficult to accomplish, since leuco indo-phenol is easily autoxidizable. It does not appear from an examination of the literature that such a demonstration has been made.

For demonstrating the oxidase of yeast cells, Keilin recommends a neutral 1 per cent solution of para-phenylene-diamine-hydrochloride, or the familiar "Nadi" reagent consisting of equal parts of M/100 solutions of di-methyl-para-phenylene-diamine-hydrochloride and alpha-naphthol in 50 per cent alcohol and 125 per cent aqueous sodium carbonate. These reagents by definition would demonstrate the presence of the indo-phenol oxidase. It is very important to note that Tolomei ('96), Grüss ('01), and Issajew ('04) also found an oxidizing enzyme in yeast by the use of various polyphenols. This oxidase by definition would be a catechol oxidase. Happold ('30) has studied the ability of bacteria to oxidize polyphenols and dimethyl-para-phenylene-diamine. Positive tests with these two reagents would correspond to Keilin's catechol oxidase and indo-phenol oxidase respectively. Positive oxidase reactions were found for eleven different bacteria. Of these, only *Staphylococcus albus* failed to give the oxidase reaction with catechol and the para-phenylene-diamine.

The work of Cook, Haldane and Mapson ('31) shows that it is entirely probable that different oxidases may exist in the cell. These workers studied the effect of carbon monoxide on the oxidation of various substances by *Bacillus Coli,* and concluded that the cell contains a number of oxidases differing from one another as do the different hemoglobins.

As pointed out above, Bunzell ('16) found an oxidase in tomato juice which acted upon pyrogallol and was therefore a catechol oxidase. In the present work the presence of an indo-phenol oxidase was determined by the use of the modified "Nadi" reagent. It is possible and probable that the catechol enzyme was the active catalyst in both cases.

The essential consideration in evaluating the work of Keilin and of other workers who postulate a great importance for the oxidases in respiration is that the hydrogen acceptor—the chromogens of Palladin, the respiration ferment of Warburg, the cytochromes of Keilin, etc—is oxidized by their activity, and may then function again as a hydrogen acceptor. With this view, it is not necessary to separate the indo-phenol oxidase of Keilin and the catechol oxidase of other workers.

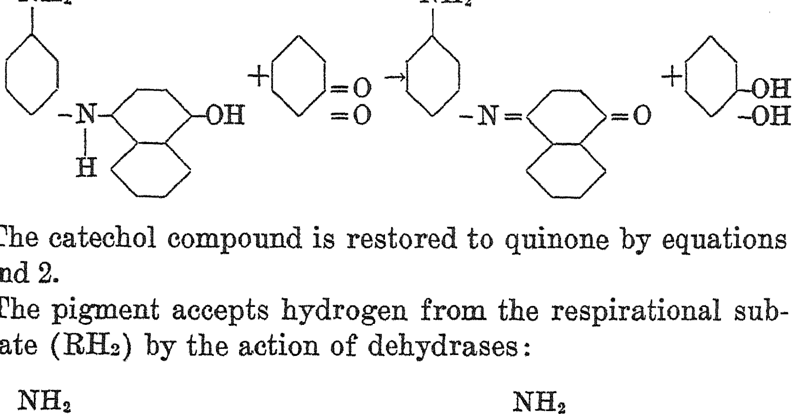
### D. POSSIBLE ENZYMATIC SYSTEMS

*Oxygenase-catechol-catalase.*—Considering the indo-phenol as an artificial respiratory pigment we may arrange the following oxygenase-catechol-catalase system. In all reactions in which indo-phenol occurs, it is intended to figuratively represent all hydrogen acceptors which have been postulated by other workers and which are reversibly oxidized and reduced.

Oxygenase produces quinone and peroxide by equations 1 and 2.

The quinone restores the chromogen to the pigment. The power of quinones to accomplish this has been verified in the present work by *in vitro* experiments:

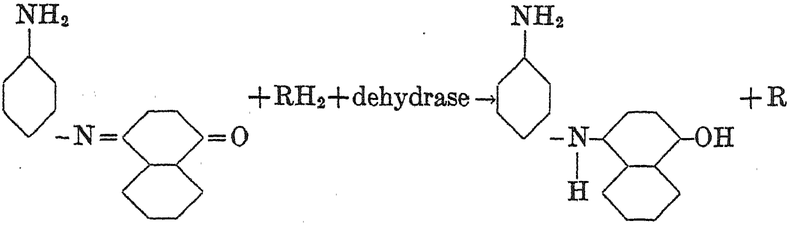
5.



The catechol compound is restored to quinone by equations 1 and 2.

The pigment accepts hydrogen from the respirational substrate ($RH_2$) by the action of dehydrases:

6.

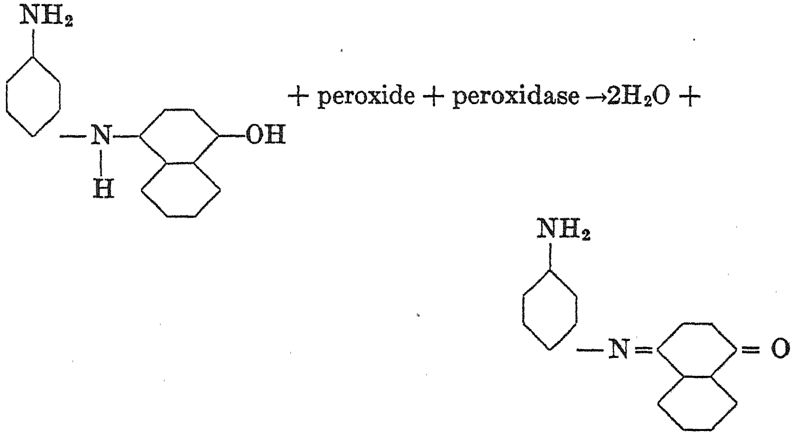


The above system would be theoretically self-perpetuating. The toxic effect of the accumulating hydrogen peroxide could be prevented by catalase. In such a case catalase would be intimately associated with the respirational process and might be expected to fluctuate more or less proportionally with it.

Zaleski and Rosenberg ('11), Appleman ('18), Crocker and Harrington ('18), Burge ('20), and many others have sought to establish a relationship between this enzyme and respiration. Since it is assumed that catalase releases only molecular oxygen from hydrogen peroxide it would be difficult to account for the direct value of this additional oxygen for respirational processes in the presence of an abundance of atmospheric oxygen. If, however, the oxygenase-catechol system is accepted as an effective oxidation mechanism, then catalase would bear a necessary but indirect relation to the respiratory process.

*Oxygenase-catechol-peroxidase.*—It is also possible to set up a series of equations showing an oxygenase-catechol-peroxidase system. The chromogen formed by reaction 6 might be restored by the action of peroxidase and the peroxide formed by reactions 1 or 2.

7.



This would not, of course, prevent the chromogen being oxidized also by equation 5. By this system it is possible to account not only for the lack of proportionality between catalase and respirational intensity as has been reported by Ranjan and Mallik ('31), Rhine ('24), Harvey ('24), and McLeod and Gordon ('23), but also to explain the coordinate rise of both oxygenase and peroxidase in the heightened respirational rate of plants suffering from disease. A correlation between the oxygenase and peroxidase under pathological condition has been often reported. Suzuki ('00, '02 a) observed this condition in the mulberry dwarf disease in Japan; Woods ('02) reported it for the mosaic disease of tobacco; and Reed ('12) found that the extract from apples infected with bitter-rot (*Glomerella rufomaculans*) showed an increased activity of these enzymes. Doby ('11, '12) observed the same condition in potato tubers infected by the Rosette disease.

*Invertase-peroxidase.*—A third relation may be also postulated which involves a relationship between invertase and peroxidase. Since this theory places great importance on the recent work of Ranjan and Mallik ('31), their work will be reported in some detail. They found that the edible pea during germination exhibits a gradual rise of respiration, while the catalase falls slightly at first, then rises to a maximum, and again falls. The leaves of *Magnifera indica* showed a parallel decrease in respiration and catalase until yellowing set in. At this time catalase increased greatly, showing that the correlation existed only in the younger stages. The same results were found with the leaves of *Eugenia jambolana.* An analysis of the sugar content of the leaves of both these species showed that the curves of monosaccharide content almost exactly paralleled those of catalase activity.

In order to ascertain whether the sugar controlled the catalase or the catalase controlled the sugar, the stems of *Allium tuberosum* were injected with sugar, and some of the plants put in the light and others in the dark. The following important relation was discovered. It was not the hexose *presence* but the *formation* of hexose, either by photosynthesis or by the hydrolysis of disaccharides, which correlated with a high catalase activity. The injection of cane sugar accompanied a greater catalase activity than did glucose, although the amount of glucose present in the former case was related to the amount of catalase.

The apparent correlation between catalase and respiration as reported by other authors is explained by the fact that normally the formation of monosaccharides parallels respirational activity. Hexoses are being formed in old leaves since the complex carbohydrates are being broken down for translocation, and this accounts for the increased catalase at this stage. It is further pointed out that high catalase may be associated with low respiration unless high respiration is associated with the formation of hexose.

The present author proposes to relate the above phenomenon to account for the existence of an invertase-sugar-peroxidase respirational mechanism in the tomato plant under the conditions of the experiment. Waldschmidt-Leitz ('29) points out that the only known substrate for catalase is hydrogen peroxide. Since this substance is not demonstrated in tissues, it follows that the action of catalase or peroxidase uses it as rapidly as formed. The work of Ranjan and Mallik may therefore be interpreted as indicating that hydrogen peroxide, or a peroxide group resembling it but not yet recognized, develops during the formation of hexose. This is particularly evident, since it has been widely observed that an enzyme develops more or less proportionally to the concentration of its substrate. Rhine ('24) believed that catalase developed in plant tissue proportionally to the need of the plant to overcome the toxic effects of hydrogen peroxide.

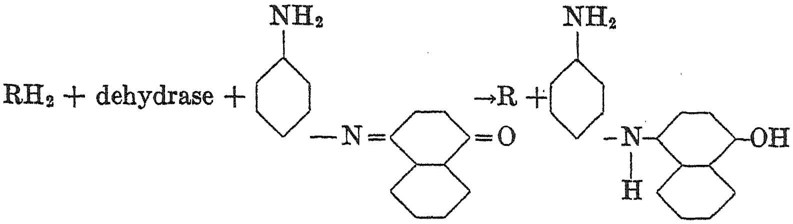
Without entering the discussion concerning the importance of the ratio of sucrose to hexose in plant tissue in its relation to photosynthesis, we may note that sucrose often accumulates in a great excess over hexose. Davis and Sawyer ('16) studied the potato, a plant closely related to the tomato, and observed that sucrose was greatly in excess of hexose, and concluded that it was therefore the first sugar of photosynthesis. The same relationship has been found in many plants.

Regardless of whether sucrose is or is not the first sugar of photosynthesis, it is important for our hypothesis to note its predominance over hexose in plants closely related to the tomato. Onslow ('31) reviewed the literature concerning the substrate for respiration, and shows that most of the data support the belief that a hexose, probably fructose, is this substrate. An increased rate of respiration would therefore call forth an increased invertase action to produce the hexose from sucrose. Since catalase has been shown to parallel the formation of hexose, it may be assumed that a transitory peroxide also develops simultaneously. Peroxidase might well use the peroxide then formed in the usual oxidation of chromogens. The comparatively small catalase increase might be thought of as a safety reaction destroying the peroxide in excess of the peroxide needs. The reaction may be represented as follows:

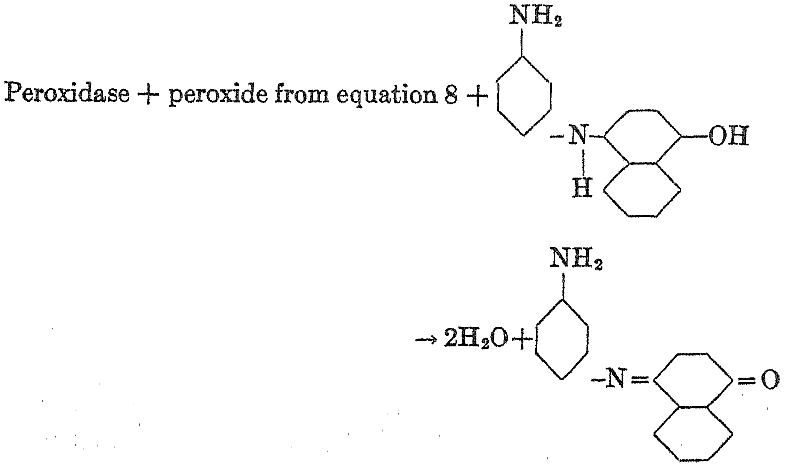
8. Sucrose + invertase → glucose + fructose + peroxide group.

9. Hexose + anaerobic enzymes → fermentation products.

10. Fermentation products indicated as $RH_2$



11.



An examination of the curves for respiration, and enzymatic activity in the present work shows interesting relationships. The increase in respiration is paralleled by peroxidase and diastase. Catalase also increases but not conspicuously, while oxygenase actually decreases.

The divergence of the respiration and oxygenase curves shows clearly that any such mechanism as the oxygenase-catechol system does not account for the increased respirational activities in this case.

The divergence of the peroxidase and oxygenase curves shows that the oxygenase-catechol-peroxidase system is not functioning.

The close correlation between the curves for respiration, invertase, and peroxidase indicates the possibility of the invertase-peroxidase series of reactions, and that this may be the mechanism for the increased respiration of the tomato plants grown in high potassium iodide solution. It seems probable that plants, such as horse-radish (*Cochlearia Armoracia*), which contain peroxidase but no oxygenase, might also depend on the invertase-peroxidase association. Certainly the possession of a strong peroxidase activity would be useless to a plant unless peroxides were available, either from such a reaction as suggested above for invertase or arising spontaneously by a non-enzymatic reaction.

## V. CONCLUSIONS

1. Potassium iodide, in the concentrations used, exerted only a depressing influence upon growth.

2. Toxic effects consisted of a loss of green color and a progressive dropping of the lower leaves. No definite spotting of the leaves was observed.

3. No significant change in the acidity of the expressed sap was observed. The pH remained very close to 5.9. This prohibited the possibility of increased enzymatic activity being due to a more favorable pH of the sap.

4. Respiration, peroxidase, and invertase were decreased by a low concentration of potassium iodide (1 p.p.m.), but

greatly increased at the higher concentration. This increase does not parallel the degree of iodine injury. The increase of catalase at the higher concentrations was much less than that of respiration, peroxidase, or invertase.

5. Oxygenase activity is progressively lowered in the plants growing in higher potassium iodide concentrations, thereby differing from the other oxidizing enzymes studied. This is important evidence that the oxygenase-catechol system is not intimately concerned with the respiratory activity of the tomato plant.

6. The activity of peptase is not affected in the plants growing in different potassium iodide concentrations.

7. The stimulating effects observed on respiration and oxidizing activities of the injured plants are not similar to those induced by disease injury reported for other plants, since disease injury is known to increase also oxygenase.

8. A possible relationship of invertase to peroxidase and the effect of this relationship on respiration have been suggested, which may account for the increased respiration rate of the plant growing in the higher concentration of potassium iodide. This mechanism involves the formation of a transitory peroxide group during the formation of hexose from sucrose by the action of invertase. This peroxide may then be activated by peroxidase which oxidizes the hydrogen acceptor.

## VI. ACKNOWLEDGMENTS

The author wishes to express his appreciation to Dr. E. S. Reynolds, Professor of Plant Physiology, Washington University, for the continued and cooperative interest shown throughout the progress of the work, and also to Dr. G. T. Moore, Director of the Missouri Botanical Garden, for the use of the library of that institution.

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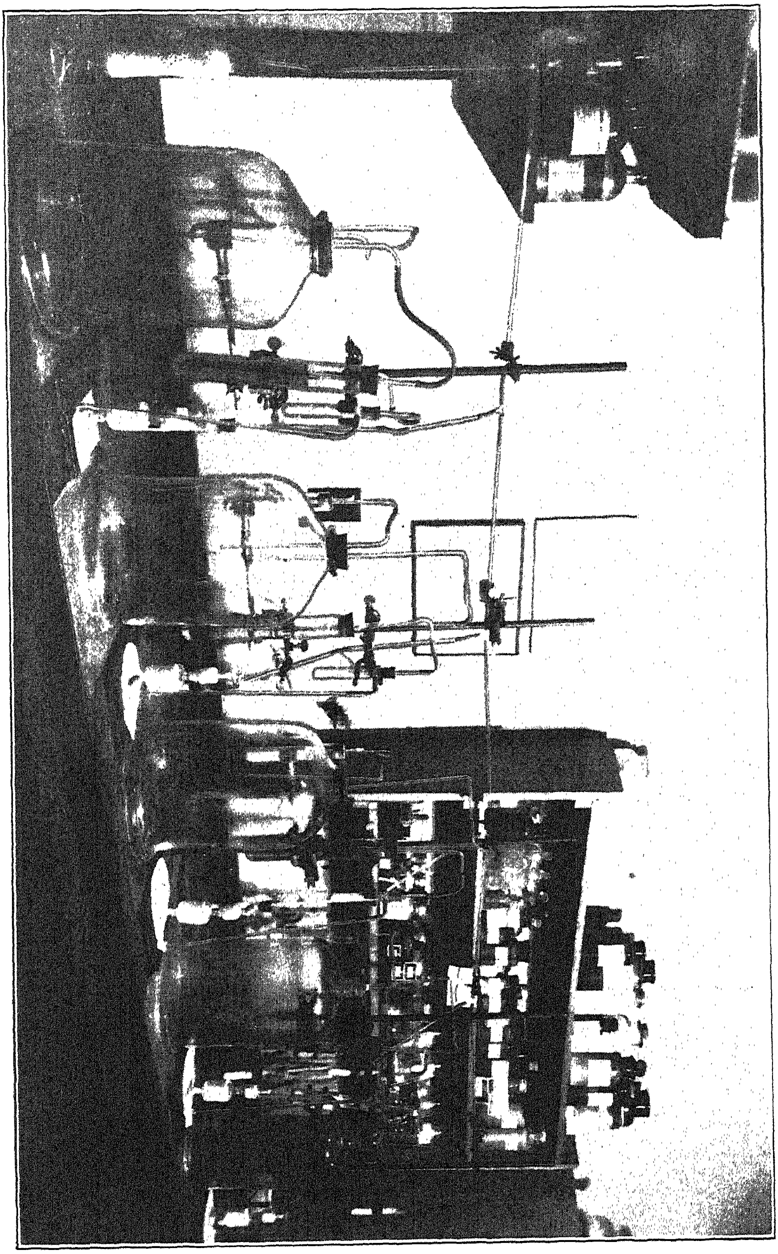
## EXPLANATION OF PLATE

### PLATE 17

The respiration chambers (see Wynd, '32).



WYND—RESPIRATION CHAMBERS

Annals
of the
Missouri Botanical Garden

VOL. 21 SEPTEMBER, 1934 No. 3

# STUDIES IN GRINDELIA. II[1, 2]

## A MONOGRAPH OF THE NORTH AMERICAN SPECIES OF THE GENUS GRINDELIA

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### INTRODUCTION

Since *Grindelia* was established by Willdenow[3] in 1807, it has been recognized by practically all botanists as one of the most distinct and homogeneous genera in the Compositae. Because of this homogeneity, somewhat analogous to the situation in *Viola*, *Rubus*, *Crataegus*, *Salix*, etc., from the outset there has been difficulty in differentiating the various species. All authors seem to have avoided detailed study of the species and their relationships, and as a result the genus as a whole has never received a critical comprehensive monographic treatment. In 1931 Cabrera[4] published a comprehensive re-

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[1] Studies in Grindelia. III, to be published subsequently, will contain a detailed discussion of the history, morphology, geographical distribution, phylogeny, economic uses, and relationships of the genus.

[2] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University. (Abridged for publication.)

[3] Willdenow, C. L., Mag. Nat. Fr. Ber. 1: 260. 1807.

[4] Cabrera, A. L., Revision de las especies Sudamericanas del genero "*Grindelia*," in Rev. Mus. La Plata 33: 209. 1931.

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vision of the South American species, but the North American species have had no particular attention since Dr. Gray treated them in the 'Synoptical Flora of North America'; moreover, the Mexican species have never been treated. The present investigation was begun in 1930 and is still being carried on. The lack of any critical work on the group was realized early in the study of historical types. Most of the names were found to have been misapplied, types of species have been misinterpreted, and the specific complexity of the various entities has never been satisfactorily worked out. All these factors contributed to the chaotic condition in the genus, and most of the current names in manuals and floras have had to be changed or dropped and replaced by new or older ones.

In order to cope satisfactorily with such a complex of confused and variable entities, it was necessary to examine large suites of herbarium material, as well as to carry on detailed field and experimental studies. Fortunately, the author has had access to material from the principal herbaria in the United States and from many smaller herbaria and has had the privilege of examining the actual historical types or photographs and fragments of the types of all the North American species and varieties. Field studies have been pursued three consecutive summers, that of 1931 having been spent in the western United States for the purpose of studying the environment and habitats of as many species as possible, and making collections of all the variations. About thirty species and almost as many varieties and forms have been grown from seed at the experimental greenhouses of the Missouri Botanical Garden, and later transplanted outdoors, and detailed studies of the seedling stage have been made.

For the privilege of studying the herbarium material or photographs of material appreciation is hereby expressed to the curators of the various herbaria. Numerous persons have aided the present study in many ways. Especial thanks are due Mr. John T. Howell, of the California Academy of Sciences, for collecting seeds and in carrying on detailed field studies in California; Dr. S. F. Blake, of the United States Department of Agriculture, and Mr. C. A. Weatherby, of the Gray

Herbarium, for helpful suggestions, advice, and information. To Dr. George T. Moore, Director of the Missouri Botanical Garden, the author is under obligation for the use of the excellent library and herbarium and the privilege of doing work in the experimental greenhouses and outside plots. Above all, the writer wishes to express his most sincere appreciation to Dr. J. M. Greenman, Curator of the Herbarium of the Missouri Botanical Garden, and to Dr. B. L. Robinson, Curator of the Gray Herbarium of Harvard University, for the assistance rendered at all times during the course of this study.

## Abbreviations

In the citation of specimens the herbaria from which material or photographs have been studied are indicated by the following abbreviations: S. F. Blake (B); Botanical Garden and Museum of Berlin-Dahlem (BER); British Museum of Natural History (BM); Brigham Young University (BY); University of California (CAL); National Herbarium of Canada (CAN); Carnegie Museum (CAR); California Academy of Sciences (CAS); V. L. Cory (CO); C. C. Deam (D); J. A. Ewan (E); Field Museum of Natural History (F); Gray Herbarium of Harvard University (G); A. O. Garrett (GA); De Candolle Herbarium at Geneva (GEN); Museum d'Histoire Naturelle de Paris (HN); University of Idaho, Southern Branch (IS); W. L. Jepson (J); Royal Botanical Gardens, Kew (K); Missouri Botanical Garden (M); Michigan Agricultural College (MA); University of Missouri (MO); University of Minnesota (MU); Edward L. Greene Herbarium of Notre Dame University (N); New York Botanical Garden (NY); Oregon State Agricultural College (O); F. W. Peirson (P); Academy of Natural Sciences, Philadelphia (PA); Philadelphia Botanical Club (PB); Pomona College (PO); Rocky Mountain Herbarium of the University of Wyoming (R); Santa Barbara Museum (SB); Dudley Herbarium, Stanford University (ST); University of Utah (UU); University of Oregon (UO); United States National Herbarium (US); University of Texas (UT); University of Washington, at Seattle (UW); State College of Washington, Pullman (WSC); Willamette University (WI).

The specimens cited represent only a small portion of the material examined.

## Taxonomy

**Grindelia** Willd. in Mag. Ges. Nat. Fr. Ber. **1**: 260. 1807; Enum. Pl. **2**: 894. 1809; R. Br. in Trans. Linn. Soc. Lond. **12**: 102. 1818; Dunal in Mem. Mus. Par. **5**: 46. 1819; HBK. Nov. Gen. & Sp. **4**: 309. 1820; Less. Syn. Gen. Compos. 163. 1832; DC. Prodr. **5**: 314. 1836; Endl. Gen. Pl. 383. 1838; Torr. & Gray, Fl. N. Am. **2**: 246. 1842; Benth. & Hook. Gen. Pl. **2**: 250. 1873; Gray in Cal. Geol. Surv. Bot. **1**: 303. 1876; Gray, Syn. Fl. N. Am. $\mathbf{1}^2$: 116. 1884, and ed. 2. 116. 1888; Rob. & Fern. in

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*Donia* R. Br. in Ait. Hort. Kew. ed. 2. **5**: 82. 1813, not *Donia* R. Br. 1819, nor *Donia* G. Don, 1832.

*Thuraria* Nutt. in Fras. Cat. 1813, not *Thuraria* Molina, 1782.

*Aurelia* Cass. in Bull. Soc. Philom. 175. 1815; in Jour. Phys. **89**: 32. 1819; Dict. Sci. Nat. **37**: 468. 1825, not *Aurelia* J. Gay, 1858.

*Demetria* Lag. Gen. & Sp. Nov. 30. 1816.

*Hoorebekia* Corn. in Mussche, Hort. Gand. 13. 1817.

*Doniana* Raf. Am. Month. Mag. 268. 1818.

Herbaceous or suffruticose, caulescent, glabrous or pubescent annuals, biennials, or perennials. Stem simple and monocephalous to corymbosely or paniculately much-branched, with few to numerous heads. Leaves alternate, sessile or the lower and basal petiolate, simple, entire to pinnatifid, more or less resinous-punctate. Heads discoid or radiate, homochromous, when radiate heterogamous, many-flowered. Disk depressed-hemispherical to deeply campanulate. Involucre more or less resinous, 4–8-seriate, the involucral bracts mostly graduate, linear- or filiform-subulate to ovate-lanceolate, with short acute to elongated apices, the lower part more or less indurated and appressed to the disk, the upper part erect and appressed, ascending to strongly revolute, glabrous or pubescent, flattened to terete, entire, at least the inner bracts resinous-punctate. Receptacle flat to very slightly convex, more or less deeply foveolate, the receptacular processes often well developed into linear or ovate, acute to acuminate projections resembling reduced paleae. Ray-florets 15–45, ligulate, pistillate, fertile, the ligules pale lemon-yellow to orange, linear-oblong to broadly oblong-spatulate, obtuse to acute, subentire to obscurely 3-lobed at apex. Disk-florets perfect, tubular, yellow, the throat gradually or abruptly constricted about half-way into a slender tube, the limb 5-toothed. Anthers with acutish to obtuse, entire, broadly deltoid or ovate bases, the terminal appendages more or less elongated, oblong-lanceolate to ovate, acutish or obtuse; style-branches of ray-florets straight, erect or ascending, slender, glabrous or essentially so throughout, without dorsally hispidulous terminal appendages; style-branches of disk-florets straight, erect, ascending or slightly spreading, with terminal appendages narrowly linear-lanceolate to ovate-oblong, and sparsely to densely hispidulous or hirsutulous-pubescent on the surface and along margins, the papillate stigmatic lines extending along the margins of the stylar branches to the base of the terminal appendage. Pappus of disk- and ray-florets of mostly 2–10 (rarely up to 15) caducous, entire to numerously setulose, slender, nearly capillary to strongly paleaceous awns. Achenes narrowly oblong to broadly rhomboid or cuboid, horizontally truncate to 1–3-knobbed, with tooth-like processes or irregularly shallowly to conspicuously undulately bordered at apex, the pericarp glabrous, smooth to convolutely rugose, compressed to subquadrangular; achenes of the disk-florets sterile to (the outer) fertile, those of the ray-florets triquetrous to quadrangular, fertile.

### KEY TO SPECIES, VARIETIES, AND FORMS OF GRINDELIA

A. Upper portions of involucral bracts erect, ascending, horizontally spreading or slightly reflexed-squarrose.......... B

B. Pappus awns filiform or capillary, or, if subpaleaceous but appearing capillary in some Texan and New Mexican species, the free portion of the involucral bracts subcoriaceous and firm and much thickened; includes all Mexican species and two from Texas and New Mexico (refer to BB for exceptions).......... C

C. Heads radiate.......... D

D. Leaves gradually reduced towards the heads, the heads not leafy-bracted; mature achenes longer than broad.......... E

E. Rays 17–22 mm. long.......... *6. G. Nelsonii*

EE. Rays 5–16 mm. long.......... F

F. Pappus awns serrulate to setulose.......... G

G. Upper and middle cauline leaves dentate to setulose or spinulose-denticulate; achenes smooth to striate or somewhat coarsely ribbed, 2.5–4 mm. long.......... H

H. Stems, at least in upper half, more or less pubescent; leaves mostly minutely puberulent on both surfaces.......... *24. G. scabra*

HH. Stems glabrous throughout; leaves glabrous on both surfaces.......... *24a. G. scabra* var. *neomexicana*

GG. Upper and middle cauline leaves finely and closely crenulate; achenes conspicuously 9–10-costate with slender ribs, 2–2.3 mm. long................................*5. G. grandiflora*
FF. Pappus awns entire or subentire.............................. I
I. Mature achenes smooth to slightly striate or shallowly rugulose or wrinkled.................................... J
J. Stems and leaves glabrous; upper cauline leaves evenly and closely serrulate with setulose- or spinulose-tipped teeth. ........................................*28. G. Greenei*
JJ. Stems, at least towards heads, and leaves pubescent, often glandular; upper cauline leaves crenulate-serrulate to serrulate with broad to deltoid or slender obtuse to acuminate teeth .................................. K
K. Rays 5–7 mm. long......................*3. G. Robinsonii*
KK. Rays 8–16 mm. long................................ L
L. Stems predominantly glandular; involucral bracts always glandular .................................. M
M. Plant 5 dm. or more tall, corymbosely branched; involucral bracts green throughout.............. ................................*4. G. Greenmanii*
MM. Plant less than 5 dm. tall, mostly simple; involucral bracts more or less purplish.................... .....................*1a. G. inuloides* var. *glandulosa*
LL. Stems predominantly villosulous; involucral bracts glabrous or sparsely glandular...................... N
N. Leaves and bracts thinnish; involucral bracts slightly resinous, tips mostly flattened............. O
O. Floriferous branchlets several, strict, uniformly foliose, sparsely villous and eglandular towards the heads; achenes slightly rugulose to finely verruculose.........................*9. G. Palmeri*
OO. Floriferous branchlets few, arcuate-ascending, minutely bracteate and villous to hirtellous-glandular towards the heads; achenes smooth or slightly striate.....................*1. G. inuloides*
NN. Leaves and bracts firmly membranaceous to subcoriaceous; involucral bracts conspicuously resinous, tips subterete..............*10. G. subdecurrens*
II. Mature achenes conspicuously and deeply rugose, or convolutely-wrinkled, or finely rugulose-verruculose............. P
P. Stems and leaves more or less pubescent................... Q
Q. Floriferous branchlets densely foliose; achenes large, 3.5–4.5 mm. long, conspicuously and deeply convolutely rugose-wrinkled......................*2. G. sublanuginosa*
QQ. Floriferous branchlets not densely foliose; achenes small, 1.8–2 mm. long, rugose-wrinkled..............*7. G. tenella*
PP. Stems and leaves glabrous throughout..................... R

R. Disk in anthesis 0.7–1 cm. high, 0.8–1.6 cm. broad.................................................*14. G. oxylepis*

RR. Disk in anthesis smaller, 0.5–0.7 cm. high, 0.5–0.7 cm. broad......................*14a. G. oxylepis* f. *capitellata*

DD. Leaves not reduced towards the heads, the heads conspicuously leafy-bracted; mature achenes as broad as or even broader than long...... S

S. Stems, at least above, and leaves glandular-villosulous or glandular-hirtellous .................................................... T

T. Disk small, less than 2 cm. broad; pappus awns mostly dilated at apex; plants of Texas........................................ U

U. Stem 2 dm. or more tall, conspicuously ramose; heads rather numerous...............................*8. G. microcephala*

UU. Stem less than 2 dm. tall, not conspicuously ramose; heads few.........................*8a. G. microcephala* var. *pusilla*

TT. Disk larger, 2 cm. or more broad; pappus awns not dilated at apex; plants of Mexico.........*8d. G. microcephala* var. *montana*

SS. Stems and leaves eglandular.................................... V

V. Margins of upper leaves narrowly setulose-denticulate, the base strongly ampliated...........*8b. G. microcephala* var. *adenodonta*

VV. Margins of upper leaves broadly crenulate-serrulate, the base less ampliated....*8c. G. microcephala* var. *adenodonta* f. *angustior*

CC. Heads discoid ............................................... W

W. Leaves commonly crenulate-serrulate, obtuse; involucre rather conspicuously resinous, tips of bracts spreading to slightly reflexed-squarrose, subulate; mature achenes conspicuously and finely convolutely-wrinkled.....................*14b. G. oxylepis* var. *eligulata*

WW. Leaves mostly subentire, acute; involucre scarcely resinous, tips of bracts erect and appressed, acute; mature achenes mostly smooth ..................................................*29. G. oolepis*

BB. Pappus awns subpaleaceous to strongly paleaceous, or if appearing capillary, the species not from Mexico nor with rugose-wrinkled achenes; species of Western United States.................................. X

X. Heads radiate................................................. Y

Y. Free portion of involucral bracts 3 mm. or less long, acute to short subulate ................................................ Z

Z. Salt or brackish marsh species................................ a

a. Stems of season arising from ligneous axis up to a meter tall; upper leaves narrowed to base, slightly to not at all amplexicaul.. b

b. Involucral bracts with mostly straight short appressed, ascending or spreading tips, or the outer slightly reflexed........... c

c. Stems of the season glabrous...................*32. G. humilis*

cc. Stems of the season densely hirtellous-pubescent or villous .............................*32b. G. humilis* f. *pubescens*

bb. Involucral bracts with tips more subulate and strongly reflexed or recurved to revolute..........*32a. G. humilis* f. *reflexa*

aa. Stems of season arising directly from crown of perennial taproot, herbaceous throughout; upper leaves not narrowed to base, strongly amplexicaul or subamplexicaul......*33. G. paludosa*

ZZ. Species of the interior, or, if near the coast, not salt or brackish marsh types .......... d

d. Main cauline leaves pinnatifid or incised-dentate throughout .......... *22. G. laciniata*

dd. Main cauline leaves entire, serrate or serrulate, dentate or denticulate, but never pinnatifid throughout .......... e

e. Leaves abundantly and conspicuously resinous-punctate throughout; stigmas linear to narrowly oblong-lanceolate.... f

f. Stems 0.25–0.6 m. tall, slender, corymbosely branched above with divergently spreading to ascending floriferous branchlets .......... g

g. Stems several; upper leaves mostly oblong-lanceolate; lower and middle cauline leaves subamplexicaul .......... *30. G. Hallii*

gg. Stems solitary; upper leaves mostly ovate-lanceolate; lower and middle cauline leaves distinctly amplexicaul .......... *34c. G. camporum* var. *abbreviata*

ff. Stems 1.1–3 meters tall, stout, mostly paniculately much-branched with closely ascending and elongated floriferous branchlets .......... h

h. Leaves firm, presenting a resinous-lustrous appearance; achenes more than 4 mm. long; rays 16–18 .......... *34a. G. camporum* var. *parviflora*

hh. Leaves less firm, presenting a less resinous-lustrous appearance; achenes less than 4 mm. long; rays 32–44 .......... *31. G. procera*

ee. Leaves scarcely, if at all, resinous-punctate; stigmas broadly oblong or oblong-lanceolate .......... i

i. Mature achenes horizontally truncate at apex; rays 7–10.5 mm. long; species of the Colorado Plateau and adjacent region .......... j

j. Pappus awns 3.3–5 mm. long, acute to shortly acuminate.... k

k. Main cauline leaves finely and remotely setulose-denticulate with fine short teeth scattered from base to apex .......... *23. G. arizonica*

kk. Main cauline leaves sharply serrate or dentate with rather broad spinulose- or setulose-tipped teeth, remotely denticulate or serrulate about apex to entire.... l

l. Main cauline leaves serrate or denticulate only towards apex, 5–8 times longer than broad .......... *23a. G. arizonica* var. *stenophylla*

ll. Main cauline leaves serrate or dentate, usually throughout the entire length, 1¾–4 times longer than broad .......... *23b. G. arizonica* var. *dentata*

jj. Pappus awns 5–6.5 mm. long, attenuate-acuminate .......... *23c. G. arizonica* var. *microphylla*

ii. Mature achenes bordered at apex with an undulate or unequal ridge, or 2–3-knobbed with short tooth-like projections; rays 10–20 mm. long; species of the California coastal region .......................................... m

m. Stems mostly glabrous (rarely pubescent); leaves mostly glabrous; main middle and lower cauline leaves amplexicaul; pappus awns usually moderately to numerously serrulate .......................................... n

n. Stems glabrous.........................*43. G. maritima*

nn. Stems pubescent.............*43a. G. maritima* f. *anomala*

mm. Stems mostly pubescent (sometimes glabrous in some varieties of *G. hirsutula*); leaves mostly puberulent or villosulous; main middle and lower cauline leaves mostly narrowed at the base (or in *G. hirsutula* subamplexicaul to amplexicaul); pappus awns usually entire or subentire.. o

o. Involucral bracts obviously graduate, the outer mostly shorter .......................................... p

p. Involucral bracts 4–6-seriate, not conspicuously crowded, with acute to short subulate tips; leaves not crowded on the stems.......................... q

q. Outer and middle involucral bracts hirsutulous throughout, the outer 7–9 mm. long, loose with spreading or slightly recurved slender tips...... ..................................*42. G. hirsutula*

qq. Outer and middle involucral bracts glabrous to densely tomentose or hirsutulous, the outer 3–7 mm. long, mostly erect and appressed with short acute or short subulate tips..................... r

r. Stems, especially above the middle, more or less loosely crisp- or villous-pubescent.............. s

s. Involucral bracts glabrous to puberulent........ t

t. Floriferous branchlets leafy near the head ...........*42c. G. hirsutula* var. *brevisquama*

tt. Floriferous branchlets almost naked or bracteate near the head.......*42f. G. hirsutula* var. *brevisquama* f. *pedunculoides*

ss. Involucral bracts densely hirsutulous to densely tomentulose ........................... *42e. G. hirsutula* var. *brevisquama* f. *tomentulosa*

rr. Stems glabrous to minutely puberulent........... u

u. Stems mostly minutely puberulent; main cauline leaves entire to subentire.......... ...............*42h. G. hirsutula* var. *subintegra*

uu. Stems glabrous to glabrate; main cauline leaves denticulate to dentate or serrate....... v

v. Leaves firmly membranaceous to submembranaceous, the main cauline remotely to closely dentate with slender to rather broad acute to acuminate teeth................ *42d. G. hirsutula* var. *brevisquama* f. *glabrata*

vv. Leaves firm and subcoriaceous, the main cauline rather closely serrulate or denticulate with short sharply acute to subspinulose-tipped teeth ................................. *42g. G. hirsutula* var. *calva*

pp. Involucral bracts 7–8-seriate, conspicuously crowded, with short, subulate mostly recurved or reflexed tips; leaves crowded..... *42b. G. hirsutula* f. *cacumena*

oo. Involucral bracts not obviously graduate, the outer and sometimes the middle equalling or surpassing the height of the disk............. *42a. G. hirsutula* f. *patens*

YY. Free portion of involucral bracts 3–10 mm. long, attenuate-filiform to long-subulate .................................................. x

x. Leaves saliently and obtusely toothed........................... y

y. Stems minutely puberulent in part; leaves minutely scabridulous in part; awns 4–7 mm. long, equalling length of disk-floret; plants of western Texas and southeastern New Mexico................................................ *11. G. Havardii*

yy. Stems glabrous throughout; leaves glabrous throughout; awns 3–5 mm. long, ¾–⅞ length of disk-floret; plants of Minnesota and South Dakota south to Missouri, northern Texas, southeastern Wyoming, and introduced eastward and westward.................................................... *12. G. squarrosa*

xx. Leaves entire or with short salient acute or spinulose-tipped teeth.... z

z. Pappus awns entire or subentire, at most remotely serrulate; species not of salt marshes, sand beaches, or other coastal habitats .................................................. *

* Pappus awns mostly ¾ to equalling length of disk-floret, mostly 5–7 mm. long.................................... †

† Involucral bracts horizontally spreading to slightly reflexed-squarrose; achenes conspicuously 2–3-knobbed at apex or equally undulately bordered or knobbed; species of California ............................................ §

§ Stems, leaves, and involucral bracts glabrous.............. ¶

¶ Stems corymbosely much-branched above, bearing numerous heads, usually white to stramineous; leaves 2–4 times longer than broad, the upper typically ovate to broadly oblong-lanceolate, strongly amplexicaul..... ×

× Disk 1.1–2.5 cm. broad, 0.8–1.5 cm. high; rays 18–39, the lamina 8–11 mm. long............ *34. G. camporum*

×× Disk 0.7–1 cm. (up to 1.5 cm.) broad, 0.6–0.8 cm. high; rays 16–18, the lamina 7–8 mm. long............................ *34a. G. camporum* var. *parviflora*

¶¶ Stems sparsely or remotely corymbosely branched, bearing few heads, frequently purplish- or brownish-red; leaves mostly 4–10 times longer than broad, the upper typically linear-oblong to lanceolate, subamplexicaul .......................... *34d. G. camporum* var. *Davyi*

§§ Stems, at least in upper half, and often leaves and involucral bracts villous-pubescent to hirsutulous.......... ⊕

⊕ Outer involucral bracts not conspicuously elongated and foliaceous..............*34e. G. camporum* var. *interioris*

⊕⊕ Outer involucral bracts much elongated, foliaceous... ..............*34f. G. camporum* var. *interioris* f. *foliacea*

†† Involucral bracts erect, ascending or arcuate-ascending; achenes very slightly and mostly inconspicuously bordered at apex with slender margin or with 1–2 short projections at the angles, subtruncate; species not of California....... ≠

≠ Outer involucral bracts about equalling the height of the disk, the bracts appearing subequal; upper leaves mostly lanceolate-linear to lanceolate-oblong.................. +

+ Leaves scarcely resinous, presenting a dull surface; serration of leaves, when present, of straight outwardly directed teeth; leaves on floriferous branchlets mostly 4–12 times longer than broad............. ⊖

⊖ Uppermost leaves linear to lanceolate-oblong, 4–12 times longer than broad, less than 2 cm. broad.... ..................................*26. G. lanceolata*

⊖⊖ Uppermost leaves ovate-lanceolate, 2½–3 times longer than broad, the larger cauline 2–2.8 cm. broad...................*26a. G. lanceolata* f. *latifolia*

++ Leaves moderately and conspicuously resinous-punctate; serration of leaves of closely appressed and incurved teeth; leaves on floriferous branchlets mostly 2½–4 times longer than broad.................*27. G. littoralis*

≠≠ Outer involucral bracts less than ½ the height of the disk, the bracts appearing more graduated; upper leaves ovate-lanceolate to ovate, conspicuously spinulose-serrate....................................*25. G. texana*

** Pappus awns mostly ½–⅔ length of disk-floret, mostly 3–4.5 mm. long ............................................ ♯

♯ Main middle and upper cauline leaves broadly ovate-lanceolate, strongly amplexicaul to subcordate, 2½–4 times longer than broad, those on floriferous branchlets ovate- to oblong-lanceolate, strongly amplexicaul to subcordate, conspicuously subtending the heads........................ <

< Middle and upper leaves mostly entire; stems, at least above, glandular-villous, mostly densely pubescent throughout............................*37. G. integrifolia*

<< Middle and upper leaves coarsely dentate, those on floriferous branchlets dentate to subentire; stems mostly glabrous or sparsely villous, becoming glabrate in lower half, mostly non-glandular.................... ...........................*37a. G. integrifolia* f. *dentata*

♯♯ Main middle and upper cauline leaves linear-oblanceolate to oblong-lanceolate, narrowed or the upper subamplexicaul, 5–10 times longer than broad, those on floriferous branchlets linear-oblong to lanceolate, subamplexicaul, not conspicuously subtending the heads........................ ≦

≦ Stems glabrous to glandular-puberulent, not villous...... ........................*37b. G. integrifolia* var. *virgata*

≦≦ Stems more or less villous, more densely so towards heads ................*37c. G. integrifolia* var. *virgata* f. *villosa*

zz. Pappus awns numerously setulose to remotely serrulate, rarely entire; species in proximity of Pacific Ocean, mostly of salt marshes, sand beaches or other coastal habitats, or, if inland, on dry soils in the proximity of the ocean.................... G

G. Heads crowded in compact clusters, on short ascending mostly subracemose branchlets; leaves firm and subcoriaceous. ....................................*40. G. aggregata*

GG. Heads scattered on remotely to corymbosely branched branchlets; leaves fleshy, thin and submembranaceous to firmly membranaceous ...................................... H

H. Stems glabrous to sparsely pubescent towards heads; leaves (except for pubescence on margins) mostly glabrous on surfaces ............................................ I

I. Upper cauline leaves and those on and subtending floriferous branchlets mostly broader above the middle than at the base or of approximately the same breadth throughout, linear-oblong to oblanceolate-spatulate....... J

J. Disk 1.6–2.5 cm. broad; rays 14–19 mm. long; plants of salt marshes, sand spits, or sand beaches.............. K

K. Leaf-surface mostly dull; involucral bracts slightly to moderately resinous.......................... L

L. Stems erect, mostly 3–6 dm. tall.................. M

M. Main cauline leaves mostly 2–8 times longer than broad; heads subtended by the uppermost leaves, but these not crowded nor conspicuously elongated beneath the heads.................. N

N. Main cauline leaves oblanceolate or oblong-spatulate to lanceolate-oblong, 0.7–2 cm. broad, 5–8 times longer than broad........ ..............................*39. G. stricta*

NN. Main cauline leaves obovate-oblong, 1.5–3 cm. broad, 2½–4 times longer than broad...... ....................*39a. G. stricta* f. *venulosa*

MM. Main cauline leaves mostly 10–15 times longer than broad; heads conspicuously subtended beneath by numerous elongated leaves.......... ..................*39c. G. stricta* var. *Andersonii*

LL. Stems procumbent to decumbent, subcaespitose, 1.5–3.5 dm. tall......*39b. G. stricta* var. *procumbens*

KK. Leaf-surface usually resinous-lustrous; involucral bracts more conspicuously and abundantly resinous ......................*39d. G. stricta* var. *aestuarina*

JJ. Disk 1.1–2 cm. broad; rays 10–14 mm. long; plants of dry or rocky hillsides, slightly inland or on rocky banks or cliffs along sea-shore...*39i. G. stricta* var. *collina*

II. Upper cauline leaves and those on and subtending floriferous branchlets mostly broader at the conspicuously ampliated, subamplexicaul to cordate base than at the apex, pandurate-oblong, lanceolate to ovate or ovoid-oblong ........................................ O

O. Pappus awns entire to remotely serrulate; species of southern California north to Santa Cruz Co., and on Santa Barbara Islands, California.................... P

P. Heads conspicuously subtended by broadly ovoid-oblong to suborbicular-ovate leaves 1–3 cm. broad; main cauline leaves 3–8 cm. broad.................................*44e. G. rubricaulis* var. *latifolia*

PP. Heads sometimes subtended by linear- to ovate-lanceolate, acute to acuminate leaves 0.2–1 cm. broad; main cauline leaves 0.7–3 cm. broad...................................*44d. G. rubricaulis* var. *robusta*

OO. Pappus awns moderately to numerously serrulate to setulose; species of British Columbia and Puget Sound, Washington .............................. Q

Q. Outermost involucral bracts mostly conspicuously more elongated than the others; bracts firmly membranaceous to subcoriaceous, the free upper portion usually thickened; achenes 4.5–5.2 mm. long....................*39e G. stricta* var. *aestuarina* f. *elongata*

QQ. Outermost involucral bracts not more conspicuously elongated than the others; bracts thin and membranaceous, the free portion mostly thin and unthickened; achenes 5–7.5 mm. long...................................*39f. G. stricta* var. *macrophylla*

HH. Stems loosely to densely villous to lanulose; leaves mostly sparsely hirsutulous to closely villosulous, the midrib usually more densely villous.............................. R

R. Stems of season from branching aerial mostly elongated ligneous axes up to 2.5 dm. long, the herbaceous stems of season simple with one or few heads on unbranched or sparsely branched branchlets...............................................*39g. G. stricta* var. *Hendersoni*

RR. Stems of season arising directly or almost directly from the main caudex, the herbaceous stems of season mostly corymbosely to subcorymbosely branched with several floriferous branchlets............*39h. G. stricta* var. *lanata*

XX. Heads discoid ............................................ S

S. Upper and middle cauline leaves entire to remotely or closely crenulate-serrate to -denticulate; pappus awns remotely to moderately setulose-serrulate; mature achenes deeply ribbed or furrowed .....................................*15. G. aphanactis*

SS. Upper and middle cauline leaves closely and evenly crenate or crenate-serrate, the teeth obtuse; pappus awns mostly entire; mature achenes smooth to slightly striated.................... T

T. Main cauline leaves oval to broadly oblong, mostly 1½–3 times longer than broad.................*12b. G. squarrosa* var. *nuda*

TT. Main cauline leaves narrowly to broadly oblong or oblanceolate, mostly 4–10 times longer than broad.....................................*12c. G. squarrosa* var. *nuda* f. *angustior*

AA. Upper portions of involucral bracts revolute, strongly recurved or strongly reflexed-squarrose ................................................... B

B. Heads discoid ................................................... C

C. Mature achenes obliquely bordered at apex with 1–2 knobs or projections or the apex irregularly undulate; Pacific Coast species........... D

D. Upper leaves 3–3½ times longer than broad; pappus awns entire; species of southern California........*44c. G. rubricaulis* var. *bracteosa*

DD. Upper leaves 6–8 times longer than broad; pappus awns remotely to moderately serrulate to setulose-serrulate; species of Oregon, Washington, and Idaho................................*38. G. columbiana*

CC. Mature achenes horizontally truncate at apex or with only semblance of shallow rim; species of the Colorado Plateau, intermontane basins, and southern Plains region........................................ E

E. Disk at maturity deeply campanulate to campanulate-hemispherical, usually as high as or higher than broad; involucral bracts closely and strongly revolute in upper portion, the tips much thickened and subcoriaceous; perennials...................................... F

F. Stems 0.5–1.5 m. tall, with very elongated fastigiate floriferous branchlets; stigmas linear-lanceolate; leaves conspicuously resinous-punctate.................................*16. G. fastigiata*

FF. Stems 0.25–0.6 m. tall, with less elongated non-fastigiate and more remote floriferous branchlets; stigmas oblong-lanceolate or oblong; leaves less conspicuously resinous-punctate............... G

G. Main middle and upper cauline leaves ovate to broadly oblong, obtuse to obtusish, 1½–3 times longer than broad..*17. G. inornata*

GG. Main middle and upper cauline leaves oblong to oblong-oblanceolate, acute to acutish, 3⅔–6 times longer than broad.......................................*17a. G. inornata* var. *angusta*

EE. Disk at maturity mostly depressed- or campanulate-hemispherical, usually broader than high; involucral bracts mostly loosely or moderately reflexed-squarrose in upper portion, the tips only slightly thickened and less subcoriaceous; annuals to biennials............. H

H. Upper and middle cauline leaves entire to crenulate-serrate or -denticulate; pappus awns serrulate to moderately setulose-serrulate; mature achenes deeply ribbed or furrowed...*15. G. aphanactis*

HH. Upper and middle cauline leaves closely and evenly crenate or crenate-serrate with teeth obtuse; pappus awns usually entire or at most remotely serrulate; mature achenes smooth to slightly striate ................................................ I

I. Main cauline leaves oval to broadly oblong, mostly 1½–3 times longer than broad....................*12b. G. squarrosa* var. *nuda*
II. Main cauline leaves narrowly to broadly oblong or oblanceolate, mostly 4–10 times longer than broad...............................................*12c. G. squarrosa* var. *nuda* f. *angustior*
BB. Heads radiate .......................................................... J
J. At least the middle and upper leaves closely crenulate-serrate or crenulate, the teeth broadly obtuse and resiniferous; leaves grayish- or dark bluish-green ........................................................ K
K. Upper and middle cauline leaves 2–4 times longer than broad, ovate-oblong, subpandurate or broadly oblong.......................... L
L. Stems 0.4–1 m. tall...............................*12. G. squarrosa*
LL. Stems low and dwarfed, 0.1–0.25 m. tall...*12a. G. squarrosa* f. *depressa*
KK. Upper and middle cauline leaves mostly 5–8 times longer than broad, linear-oblong or oblong to oblanceolate.......................................................*12d. G. squarrosa* var. *serrulata*
JJ. Leaves variously dentate to serrulate, incised, or entire, but the teeth, when present, acute to acuminate; leaves dark, bright, drab, pale yellow or bright green............................................ M
M. Heads crowded or agglomerated, forming a compactly arranged cluster on short ascending mostly subracemosely branched floriferous branchlets....................................*40. G. aggregata*
MM. Heads obviously scattered on remotely to corymbosely branched floriferous branchlets ......................................... N
N. Pappus awns remotely serrulate to numerously setulose............ O
O. Basal and lower leaves cuneate to broadly rhomboid-oblong, broadly obtuse to subtruncate at apex; middle cauline leaves often broadly obtuse or subtruncate.......................... P
P. Stems of season arising from prostrate or spreading ligneous axes; lower and middle cauline leaves usually broadest above the middle; pappus awns moderately serrulate to numerously setulose-serrulate ......................................... Q
Q. Stems glabrous ......................................... R
R. Leaves firm to at most subcoriaceous; tips of involucral bracts rather slender.....................*45. G. arenicola*
RR. Leaves thick and coriaceous; involucral bracts more thickened..............*45a. G. arenicola* var. *pachyphylla*
QQ. Stems villous or hirsute........*45b. G. arenicola* f. *trichophora*
PP. Stems of season arising directly from the abbreviated caudex; lower and middle cauline leaves usually of the same breadth throughout or broadest at the amplexicaul base; pappus awns entire to moderately serrulate...................................................*44h. G. rubricaulis* var. *platyphylla*
OO. Basal and lower leaves elliptic-oblong to oblanceolate-spatulate, acute to obtuse; middle cauline leaves mostly acute............ S
S. Stems glabrous throughout; leaves glabrous.................. T
T. Stems of the season from elongated aerial basal ligneous

axes or these sometimes wanting; rays 14–25 mm. long; leaves fleshy to leathery-fleshy; maritime species.......... U

U. Stems of the season from elongated ligneous axes; leaves very coriaceous-thickened; involucral bracts with the upper portions strongly recurved or revolute; species of Humboldt Bay Region, California........*41. G. Blakei*

UU. Stems of the season arising mostly from near or on the substratum; leaves fleshy to firmly membranaceous; involucral bracts with the upper portions slightly to moderately recurved; species of southern Alaska south to northern California ................................ V

V. Leaf-surface mostly dull; involucral bracts slightly to moderately resinous ............................ W

W. Stems erect from an erect, ascending or slightly decumbent base, mostly 2–6 dm. tall.........*39. G. stricta*

WW. Stems procumbent to decumbent, subcaespitose from a procumbent to prostrate base, 1.5–3.5 dm. tall.... .....................*39b. G. stricta* var. *procumbens*

VV. Leaf-surface often appearing resinous-lustrous; involucral bracts more abundantly resinous........... ........................*39d. G. stricta* var. *aestuarina*

TT. Stems of the season arising directly from the ground; rays 7–15 mm. long; leaves submembranaceous or firmly membranaceous to subcoriaceous; interior species or if near the coast, not of sand beaches, sand spits, or salt marshes...... X

X. Interior species; mature achenes horizontally truncate at apex, not 2-3-knobbed nor undulately bordered.......... Y

Y. Involucre and bracts slightly to moderately resinous..... Z

Z. Leaves firmly membranaceous; involucral bracts with the tips rather abruptly and closely recurved, firmly membranaceous....................*21. G. decumbens*

ZZ. Leaves submembranaceous; involucral bracts loosely recurved, more membranaceous, more lax than in the species..............*21a. G. decumbens* var. *subincisa*

YY. Involucre and bracts abundantly and conspicuously resinous ........................................... a

a. Pappus awns mostly 4–8, closely and numerously setulose or setulose-serrulate; species of southeastern Wyoming and adjacent east-north-central Colorado ....................................... b

b. Stems usually several from the base, subcaespitose, slender; main cauline leaves 1.5–6 cm. long, the upper cauline oblanceolate to lanceolate-oblong, narrowed to the base...............*20. G. subalpina*

bb. Stems usually one from the base, rather stout; main cauline leaves 6–15 cm. long, upper cauline oblong to ovoid, subamplexicaul............... .....................*20a. G. subalpina* var. *erecta* aa. Pappus awns mostly 2–4 (sometimes 5–8), only remotely or moderately serrulate or setulose-serrulate or numerously serrulate; species of Canada, Montana, the Dakotas, Minnesota, Utah, Idaho, northern and central Wyoming, central and southeastern Colorado, and northern New Mexico.......... c

c. Main middle and lower cauline leaves mostly 6–10 times longer than broad, the upper cauline usually at least 5 times longer than broad................ d

d. Leaves closely and evenly crenulate-serrulate to closely serrulate, the radical and basal mostly not coarsely or irregularly incised-serrate or pinnatifid.........*12d. G. squarrosa* var. *serrulata*

dd. Leaves characteristically entire to remotely serrulate, the radical and sometimes the middle cauline often becoming irregularly coarsely serrate or pinnatifid..............*13. G. perennis*

cc. Main middle and lower cauline leaves mostly 2½–5 times longer than broad, the upper cauline at most 4 times longer than broad.................. e

e. Leaves subcoriaceous and thickened, entire to regularly rather remotely dentate or denticulate with short broad teeth............*18. G. revoluta*

ee. Leaves firmly membranaceous, saliently and sharply toothed with acute to setulose-acuminate teeth.....................*19. G. acutifolia*

XX. Coastal species of San Francisco Bay region; mature achenes bordered at apex with an undulate ridge, or 2–3-knobbed with short tooth-like projections...*43. G. maritima*

SS. Stems villosulous to lanulose at least above; leaves sparsely hirsutulous to glabrous................................. f

f. Stems usually only sparsely or more densely pubescent in upper portion or near heads, otherwise glabrous; leaves mainly glabrous or glabrate............................ g

g. Upper leaves mostly broader above the middle, linear-oblong to oblanceolate-spatulate, usually narrowed to the base; achenes 3–5 mm. long...................... h

h. Leaves fleshy, slightly or inconspicuously resinous-punctate, the surface mostly dull; disk 1.6–2.5 cm. broad; rays 14–19 mm. long; salt-marsh, moist sand-spit, or sand-beach types.................*39. G. stricta*

hh. Leaves more firmly membranaceous, more moderately or somewhat conspicuously resinous-punctate; disk averaging smaller, 1.1–2 cm. broad; rays 10–14 mm. long; plants of dry or rocky hillsides slightly inland, or rocky banks or cliffs near seashore.............................................*39i. G. stricta* var. *collina* gg. Upper leaves mostly broader at base, pandurate-oblong to lanceolate, the base mostly conspicuously ampliated, amplexicaul or subamplexicaul; achenes 5–7 mm. long .......................... *39f. G. stricta* var. *macrophylla*

ff. Stems mostly loosely or densely villous or lanulose throughout; leaves mostly sparsely hirsutulous to closely villosulous, the midrib usually more densely villous ........ ................................ *39h. G. stricta* var. *lanata*

NN. Pappus awns mostly entire or at most remotely serrulate ........... i

i. Species of salt marshes ........................................ j

j. Stems of season arising from elongated aerial ligneous axes, the ligneous portions sometimes up to 1 m. tall; main middle and upper cauline leaves linear- to spatulate-oblong, mostly narrowed at base or only slightly broader at base than maximum breadth, 0.6–1.4 cm. broad, 4–7 times longer than broad .. k

k. Entire plant 0.45–0.8 m. tall; aerial basal ligneous axes only 0.1–0.35 m. tall, the herbaceous stems of the season comprising most of the height; rays 24–45 .......... *41. G. Blakei*

kk. Entire plant often 1–1.5 m. tall; aerial basal ligneous axes woody, up to 1 m. tall, usually comprising at least half or more of the total height of the plant; rays mostly 16–26 (up to 34) ....................... *32a. G. humilis* f. *reflexa*

jj. Stems of season arising directly from the caudex at the surface of the ground; main middle and upper cauline leaves broadly oblong to ovate, strongly amplexicaul, 1.5–4.5 cm. broad, 2½–4 times longer than broad ................ *33. G. paludosa*

ii. Species not of salt marshes .................................. l

l. Main middle and lower cauline leaves conspicuously narrowed or attenuated to the base, mostly broadest about the middle or towards the apex; disk 0.6–2.2 cm. broad; plants of Montana, Idaho, Washington, Oregon, northern Nevada, and northern California .................................... m

m. Heads campanulate-hemispherical, broader than high ....... n

n. Stems mostly slender and short, 2.5–6.5 dm. tall, the leaves of the floriferous branchlets reduced and scattered ....... o

o. Inner involucral bracts 7–10 mm. long, all with elongate tips 1.5–3 mm. long, these revolute for the upper ⅓ to ⅕ of the bract; plants of southern Washington, Oregon, and northern Nevada .............. *35. G. nana*

oo. Inner involucral bracts 5–7 mm. long, all with short tips 0.4–1.5 mm. long, these shortly and abruptly revolute for the upper ⅕ to ⅐ of the bract; plants of northern and central Washington and northern Idaho and Montana .................. *35f. G. nana* var. *integerrima*

nn. Stems stouter and taller, 3–11.5 dm. tall, the leaves of the floriferous branchlets not reduced and scattered up to heads (except in *G. nana* var. *altissima*) .............. p

p. Heads few; leaves of floriferous branchlets reduced and scattered; upper leaves with the base about as broad as the middle; plants of northern California and southwestern Oregon ............................ q

q. Stems and leaves glabrous....*35c. G. nana* var. *altissima*

qq. Stems and often leaves puberulent................ ................*35d. G. nana* var. *altissima* f. *puberula*

pp. Heads rather numerous; upper leaves not reduced and scattered up to the heads; upper cauline and those on floriferous branchlets conspicuously subamplexicaul; plants of Idaho, Montana, Washington, and Oregon... r

r. Main cauline leaves mostly entire, elliptical-obovate to broadly oblong-oblanceolate, mostly 1.5–2.3 cm. broad..................*35g. G. nana* var. *Paysonorum*

rr. Main cauline leaves serrate to denticulate, oblanceolate to oblong-lanceolate, mostly 0.7–1.5 cm. broad ............................*35a. G. nana* f. *Brownii*

mm. Heads turbinate, quadrate-hemispherical or deeply campanulate, higher than or as high as broad................. s

s. Heads turbinate; floriferous branchlets fastigiately elongated; heads numerous; disk 0.65–1.1 cm. broad; main cauline leaves with a broad upper portion conspicuously attenuate to a subpetiolate base; plants of northern California and southwestern Oregon......... ............................*35e. G. nana* var. *turbinella*

ss. Heads quadrate-hemispherical to deeply campanulate; floriferous branchlets conspicuously corymbosely elongated; heads few to moderate in number; disk mostly 1–2 cm. broad; main cauline leaves with the upper portion of about the same breadth or somewhat broader than the basal portion; plants of central Washington, western Montana, eastern Oregon, and Idaho......... ...........................*35b. G. nana* f. *longisquama*

ll. Main middle and lower cauline leaves about the same breadth at the base as at the middle or conspicuously broader at base, subamplexicaul to strongly amplexicaul; disk mostly 1.5–3.5 cm. broad (sometimes as small as 1.2 cm. broad); plants of southern and central California, and St. Maries River region, Idaho ................................................. t

t. Stigmas linear-lanceolate or narrowly linear; leaves conspicuously and abundantly resinous-lustrous; pappus awns ¾ to equalling length of disk-floret................... ..........................*34b. G. camporum* var. *australis*

tt. Stigmas oblong-lanceolate or oblong; leaves scarcely to moderately resinous-punctate, but the surface mostly dull; pappus awns usually ½ to ⅔ length of disk-floret (sometimes up to ¾ length).................................. u

u. Stems, at least above, and leaves glandular; achenes horizontally truncate at apex; plants of Idaho....*36. G. Howellii*

uu. Stems and leaves eglandular; mature achenes bordered at the apex with broad projections; plants of the coast of southern and central California........................ v

v. Stems, at least above the middle, villous; leaves often villous or sparsely crisp-puberulent on both surfaces.... w

w. Heads subtended by broadly deltoid-ovate or broadly ovate leaves 1–1.5 cm. broad; main middle and lower cauline leaves 3–4 cm. long, 1½–2¾ times longer than broad, broadly ovate-oblong or ovate, subcordate to strongly amplexicaul........ .........*44g. G. rubricaulis* var. *latifolia* f. *pubescens*

ww. Heads subtended mostly by linear to oblong-lanceolate reduced leaves only 0.2–0.7 cm. broad; main middle and lower cauline leaves mostly 4–11 cm. (sometimes 3 cm.) long, 2–9 times longer than broad, linear- to obovate-oblong, narrowed to the subamplexicaul to amplexicaul base................ x

x. Upper leaves linear-oblong to ovate-lanceolate, acute to acuminate, those on floriferous branchlets much reduced towards heads; main lower and middle cauline leaves 4–9 times longer than broad ....................................... y

y. Stems more or less villous above the middle; the upper leaves saliently dentate to entire, mostly sparsely villous or crisp-puberulent on both surfaces; main lower and middle cauline leaves 4–5½ times longer than broad....*44. G. rubricaulis*

yy. Stems mostly glabrous or sparingly villosulous; the upper leaves entire or denticulate, mostly glabrous or more or less villosulous; main lower and middle cauline leaves 6–9 times longer than broad............*44a. G. rubricaulis* var. *permixta*

xx. Upper leaves oblong to rhomboid, truncate to acute, those on floriferous branchlets mostly not reduced; main lower and middle cauline leaves mostly 2–3 times longer than broad............ ........*44i. G. rubricaulis* var. *platyphylla* f. *villosa*

vv. Stems more or less glabrous throughout; leaves glabrous (except for scabridulous margins).................... z

z. Heads conspicuously subtended by broadly ovoid-oblong to suborbicular-ovate leaves 1–2.5 cm. broad; main cauline leaves 1.5–8 cm. broad......... ¶

¶ Main middle cauline leaves mostly 8–13 cm. long, 3–8 cm. broad; main cauline leaves usually remotely dentate, serrate or closely crenate-dentate with short broad acute to obtuse teeth; stems stout, 5 or more dm. tall........................................*44e. G. rubricaulis* var. *latifolia*

¶¶ Main middle cauline leaves 3–4 cm. long, 1.5–2.5 cm. broad; main cauline leaves more sharply and saliently dentate or serrate with acute to spinulose teeth; stems more slender, mostly 4–4.5 cm. tall.........*44f. G. rubricaulis* var. *latifolia* f. *minor*

zz. Heads sometimes subtended by linear- to ovate-lanceolate acute to acuminate leaves 0.2–1 cm. broad; main cauline leaves 0.7–1.8 cm. broad.............. ×

× Stems with few or several floriferous branchlets bearing few to several heads; leaves on floriferous branchlets mostly not reduced; involucral bracts not conspicuously resinous; rays 12–17 mm. long.. ⊕

⊕ Leaves mostly thin and submembranaceous or firmly membranaceous; upper cauline and those on floriferous branchlets typically acute to acuminate.........*44d. G. rubricaulis* var. *robusta*

⊕⊕ Leaves mostly subcoriaceous; upper cauline and those on floriferous branchlets obtuse or obtusish.........*44h. G. rubricaulis* var. *platyphylla*

×× Stems with much-branched floriferous branchlets bearing usually numerous heads; leaves on floriferous branchlets reduced, becoming very small towards the heads; involucral bracts conspicuously resinous; rays mostly 8–12 mm. long...........................*44b. G. rubricaulis* var. *elata*

1. **G. inuloides** Willd. in Mag. Ges. Nat. Fr. Ber. **1**: 261. 1807, not of most American authors; Willd. Enum. Pl. **2**: 894. 1809; Ker in Bot. Reg. **3**: *pl. 248.* 1817; Dunal in Mem. Mus. Par. **5**: 50. *pl. 5.* 1819; Sweet, Hort. Brit. ed. 2. 298. 1830; DC. Prodr. **5**: 315. 1836, as to synonymy and as to plant of *Humboldt & Bonpland,* not as to plants of *Berlandier 2186* nor *Berlandier 1542,* in large part as to description; Torr. & Gray, Fl. N. Am. **2**: 247. 1842, as to synonymy and excluding β and γ, not as to plants of *Berlandier, Drummond, Nuttall,* and *Douglas;* Walp. Rep. Bot. Syst. **2**: 958. 1843, in small part as to description; Loudon, Ladies' Fl. Gard. Orn. Per. **2**: 25. *pl. 55.* 1844; Hemsl. Biol. Cent.-Am. Bot. **2**: 112. 1881, as to *Bourgeau 515* and *Galeotti 2416* plants, not plants of *Parry & Palmer 371* nor *Berlandier 2186;* Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, as to synonymy chiefly, in small part as to description.

*Inula serrata* Pers. Syn. Pl. **2**: 451. 1807; Dunal in Mem. Mus. Par. **5**: 51. 1819, as synonym; Steud. Nom. Bot. **1**: 708. 1840, as synonym.

*Inula spathulata* Hort. Paris, ex Poir. Encyc. Suppl. **3**: 154. 1813.

*Demetria spathulata* Lag. Gen. & Sp. Nov. 30. 1816; Sweet, Hort. Brit. ed. 2. 298. 1830; Steud. Nom. Bot. **1**: 707. 1840, as synonym; Hemsl. Biol. Cent.-Am. Bot. **2**: 112. 1881, as synonym.

*Aster spathulatus* Hort. Roy. Madr. ex Lag. Gen. & Sp. Nov. 30. 1816, in synonymy, not *A. spathulatus* Lindl. nor *A. spathulatus* Hort. Cels. ex. Steud; Dunal in Mem. Mus. Par. **5**: 50. 1819, in synonymy; Lag. ex Nees, Gen. & Sp. Aster. 283. 1833, in synonymy; Hort. Madr. ex DC. Prodr. **5**: 315. 1836, in synonymy.

*Grindelia angustifolia* HBK. Nov. Gen. & Sp. **4**: 309. 1820, not DC. ex Dunal, 1819; Ker in Bot. Reg. **10**: *pl. 781.* 1824; Sweet, Hort. Brit. ed. 2. 298. 1830; Steud. Nom. Bot. **1**: 707. 1840, in synonymy; Loudon, Ladies' Fl. Gard. Orn. Per. **2**: 25. *pl. 55.* 1844; Hemsl. Biol. Cent.-Am. Bot. **2**: 112. 1881, in synonymy.

*Grindelia spatulata* Bernhardi ex Link, Enum. Pl. Hort. Berol. **2**: 336. 1821; Link ex Steud. Nom. Bot. **1**: 708. 1840, in synonymy.

*Grindelia pubescens* Nutt. in Jour. Acad. Phila. **7**: 74. 1834; Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, in synonymy.

*Aster serratus* Lag. ex DC. Prodr. **5**: 315. 1836, in synonymy, not *A. serratus* Thunb.; Steud. Nom. Bot. **1**: 157 and 707. 1840, in synonymy.

*Aster spathularis* Brouss. ex DC. Prodr. **5**: 315. 1836, in synonymy; HBK. Nov. Gen. & Sp. **4**: 309. 1820, in synonymy; Steud. Nom. Bot. **1**: 707. 1840, in synonymy.

*G. arguta* Schrad. ex DC. Prodr. **5**: 315. 1836; Steud. Nom. Bot. **1**: 707. 1840; Hemsl. Biol. Cent.-Am. Bot. **2**: 112. 1881, as to plant of *Humboldt & Bonpland,* not of *Wright.*

*Donia inuloides* Hook. Fl. Bor. Am. **2**: 25. [1834] 1840, in large part, excluding β (plant of *Douglas*).

Herbaceous, apparently biennial or perennial; stems one to several, erect, simple or branched with elongated subcorymbose branchlets bearing solitary terminal heads, greenish to rose-purplish, sparsely to densely villosulous, puberulent or mixed glandular-villosulous, often glabrate in the lower half, 2–4.5 dm. tall; leaves remote and bracteate towards heads, not resinous-punctate, grass- to yellowish-green, firmly membranaceous, closely and regularly serrulate with short or salient acute teeth, or subentire to entire towards heads, 0.5–5 cm. long, 0.2–1.5 cm. broad, mostly 2–5½ times longer than broad, the middle and upper linear-oblong to ovate-lanceolate or deltoid-ovate, acute to caudate, amplexicaul to subcordate, scabridulous, glandular-scabridulous or minutely glandular; disk depressed- to campanulate-hemispherical, 0.8–1.2 cm. high, 1.3–2.5 cm. broad; involucre (except the inner bracts) scarcely resinous, slightly graduate, the upper fourth to half free and spreading to slightly reflexed with short flattened tips, the bracts 3.5–10 mm. long, often green throughout, linear- to oblong-lanceolate with acuminate to caudate tips, glabrous or the outer sparsely puberulent or glandular-puberulent; rays 20–30, bright yellow or orange-yellow, lamina 11–16 mm. long, 3.2–4.3 mm. broad; achenes broadly oblong, 3–4 mm. long, 2–2.5 mm. broad, chestnut-brown, smooth or slightly striate, dull, compressed-subquadrangular, mostly subturgid, horizontally truncate at apex, the apicular portion narrow and inconspicuous as a shallow border; awns 2–4, nearly capillary, entire, 3–6.5 mm. long, about equalling or slightly less than length of disk-florets, straight.

Distribution: moist or semi-moist soil in upland meadows or slopes at altitudes of 7000–8000 ft., south-central Mexico, from Hidalgo to Oaxaca, west to Jalisco and Michoacan.

MEXICO: cultivated from Mexican seeds: "Inula spatularis, H.M. (Hortus monspeliensis acc. to Gray), 16" (G); Liverpool Garden, Oct. 9, 1820, herb. *Stead* (NY); "*Grindelia inuloides* (W)" (CAL fragment, and photograph of TYPE, CAL, G, M); MEXICO—Santa Fé sur les collines, Vallees de Mexico, July 5, 1865–1866, *Bourgeau 515* (G); wet soil, Lecheria, alt. 7300 ft., Aug. 24, 1902, *Pringle 9914* (G, M, NY, US); JALISCO—near Colotlan, Aug. 29, 1897, *Rose 3608* (G, US); MICHOACAN—Punguato, vicinity of Morelia, alt. 1950 m., Aug. 25, 1910, *Arsène 5823* (M, US); route de Mexico, vicinity of Morelia, alt. 1900 m., July 5, 1910, *Arsène 5697* (G, M, US); prope Valladolid de Michoacan et Pazcuaro, *Humboldt & Bonpland* (M photograph of TYPE of *G. angustifolia*

H. & B.); QUERETARO—between Cadereyta and Visaron, Aug. 22, 1905, *J. N. Rose, Painter & J. S. Rose 9749* (G, US); HIDALGO—wet meadows, El Salto, alt. 7000 ft., July 25, 1898, *Pringle 6927* (CAL, G, M, MA, MU, NY, PO, R, US); OAXACA—Etla, June, 1888, *Seler & Seler 79* (US); between Coixtlahuaca and Tamazulapam, alt. 7000–7700 ft., Nov. 12, 1894, *E. W. Nelson 1945* (US).

1a. var. **glandulosa** (Greenman) Steyermark, comb. nov.

*G. glandulosa* Greenm. in Proc. Am. Acad. **34**: 575. 1899.

Stems with an ascending or slightly decumbent base, mostly several, simple or occasionally branched near the base, monocephalous, mostly densely glandular but also sparsely to densely villosulous; leaves densely mixed glandular-scabridulous; middle and inner bracts purplish or rose-purplish, mostly in upper half, the inner and sometimes the middle oblong with abruptly subulate or caudate tips, terminating more abruptly than in species, minutely glandular, bracts glandular-ciliate, the margins of the middle and outer somewhat suberose.

Distribution: on wet mountain meadows, southern Mexico.

MEXICO: HIDALGO—wet meadows, Sierra de Pachuca, alt. 10000 ft., Aug. 13, 1898, *Pringle 6962* (CAL, G TYPE, M, MA, MU, NY, PA, PO, US); wet meadows, Sierra de Pachuca, alt. 10000 ft., Aug. 23, 1902, *Pringle 9913* (G, M, NY, US); PUEBLA—meadows, Boca del Monte, Tehuacan, June, 1907, *Purpus 2466* (CAL, G).

The identity of *G. inuloides* Willd. has always been a source of confusion and has never been satisfactorily ascertained. In fact, the species has been so thoroughly misunderstood that it has served as a convenient catch-all for most Mexican and some Texan species. Most American authors have confused true *G. inuloides* Willd., a strictly central and southern Mexican species, with a common Texan entity, which proves to be a common but unnamed member of the *G. microcephala* DC. group, namely, *G. microcephala* var. *adenodonta* Steyermark.

The type of *G. inuloides*, of which I have seen a photograph and fragment, is represented by a single specimen in the Willdenow herbarium at Berlin, and is the only specimen labelled "*Grindelia inuloides*" both on the sheet and on a small label. This specimen, though representing but a fragmentary upper portion of a stem from the principal cauline axis, clearly shows the solitary terminal head and small leaves gradually reduced upwards and attenuate at apex; the leaves have margins with close sharp serrulations, also quite characteristic of this species. The fragment which Willdenow preserved in his herbarium under the name *G. inuloides,* and which must be taken as the type, was obtained from a plant cultivated in the Berlin Botanical Garden and raised from seed distributed by Professor Broussonet of Montpelier under the name *Aster spathularis.* Since Broussonet originally received these seeds from Sessé who sent them from somewhere "in Mexico," the original geographical source of the seed is obscure. However, it is known that Sessé collected on his trip with Moçino in southern Mexico, and passed north into the Valley of Mexico and beyond. Collections which well match Willdenow's cultivated plant have been obtained from the states of Mexico, Michoacan, and southwards, from which geographical evidence it is clear that the seeds of Sessé's plant sent to Broussonet, and subsequently to Willdenow and others, were collected somewhere in this portion of southern or central Mexico.

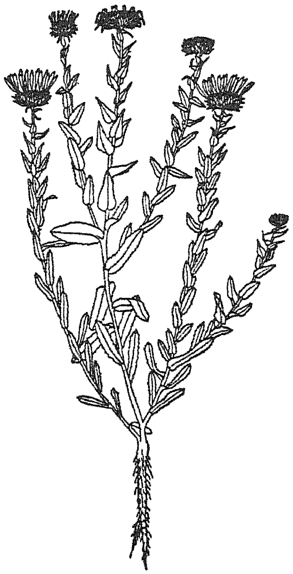

Fig. 1. *G. inuloides.* × ⅕.

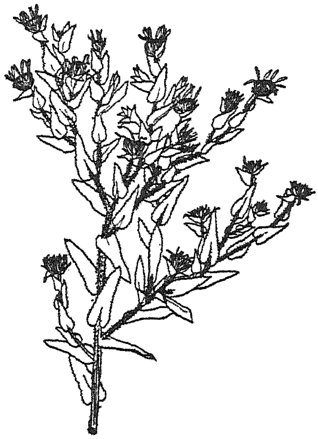

Fig. 2. *G. sublanuginosa.* × ⅕.

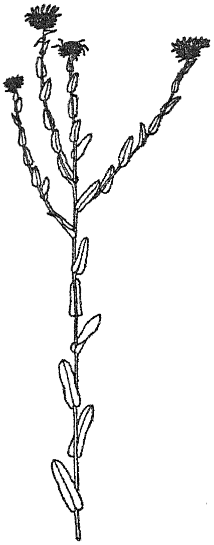

Fig. 3. *G. Robinsonii.* × ⅕.

*Grindelia angustifolia* HBK., not DC. ex Dunal, proves, upon examination of a photograph of the type preserved in the Herb. Museum d'Histoire Naturelle, to be synonymous with

*G. inuloides* Willd.; it is well matched by collections of *Arsène 5697* and *5823* taken from the vicinity of Morelia, a region proximate to that where Humboldt and Bonpland collected their *G. angustifolia. Grindelia angustifolia* is a plant with somewhat shorter and narrower leaves and smaller heads than some other collections of *G. inuloides* Willd., but there are transitions from such narrower-leaved plants to those like *Pringle 6927* and *9914* which have broader leaves and larger heads.

Nuttall's *Grindelia pubescens* is synonymous with *G. inuloides* and represents a luxuriant growth-phase of *G. inuloides,* a condition which may be due to cultivation or to more favorable growth factors. Such luxuriant plants of *G. inuloides* due to cultivation are represented by a specimen cultivated in the Liverpool Garden, Oct. 9, 1820, in Herb. Stead deposited in the Torrey Herbarium of the New York Botanical Garden, and by a specimen in Gray Herbarium cultivated as "Inula spatularis, in H. [ortus] M. [onspeliensis],[5] 16" and represented in De Candolle's Herbarium in 1839. Nuttall's specimen was supposedly collected in "Arkansas," but certainly some confusion of locality data on the labels must have occurred in this instance, because *G. inuloides* is a strictly Mexican species, never having been collected either in Texas or much less "Arkansas," and the "Arkansas" data must therefore be cast aside as a probable error.

2. **G. sublanuginosa** Steyermark, sp. nov.[6]

Herbaceous; stems erect, much-branched above with spreading or irregularly ascending densely foliose floriferous branchlets, densely villous, 4 or more dm. tall; leaves olive-green, densely mixed glandular-puberulent, hirsutulous or scabridulous on both surfaces, densely villous at the base, closely and evenly serrulate with short acute teeth, the upper leaves 2–3.5 cm. long, 0.5–1.2 cm. broad, 2½–3 times longer than broad, oblong-lanceolate to ovate, acute to acuminate, amplexicaul to subamplexicaul; heads radiate, 1.7–2.5 cm. broad; disk small, campanulate-hemispherical, 0.8–1 cm. high, 1–1.5 cm. broad; involucre 3–4-seriate, the outer and middle bracts with the upper ½–¾ free and spreading, or ascending portion 3.5–5 mm. long, flattened, lanceolate with long acuminate or subulate tips, 7–9 mm. long, firmly membranaceous, glabrous, outermost ones glandular-puberulent; rays 8–21, bright yellow or orange-yellow, the lamina 9–11 mm. long; achenes oblong, 3.5–4.5 mm. long, 2–2.2 mm. broad, quadrangular, buff to light brown, conspicuously irregularly wrinkled with rather large convolutions, horizontally truncate at apex; awns 4, capillary-linear, entire, 3.5–4.5 mm. long, equalling length of disk-floret.

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[5] The matter in brackets is supplied by the author.

[6] **G. sublanuginosa** Steyermark, sp. nov., caulibus dense villosis, ramusculis patentibus vel irregulariter adscendentibus, dense foliosis; foliis dense glanduloso-puberulis, hirsutulis vel scabridiusculis, contigue et regulariter serrulatis cum dentibus brevibus acutis, caulinis superioribus 2–3.5 cm. longis, 0.5–1.2 cm. latis, oblongo-lanceolatis vel ovatis, acutis vel acuminatis; bracteis involucri 3–4-seriatis, glabris; achaeniis oblongis, 3.5–4.5 mm. longis, 2–2.2 mm. latis, quadrangularibus, valde irregulariter rugosis.—Collected on south slope of hills fronting Lake Chapala, State of Jalisco, Mexico, January 5, 1903, *E. W. Nelson 6523* (U. S. Nat. Herb. no. 399114 TYPE, NY isotype).

Distribution: hills around Lake Chapala, State of Jalisco, west-central Mexico.

MEXICO: JALISCO—south slope of hills fronting Lake Chapala, Jan. 5, 1903, *E. W. Nelson 6523* (NY, US TYPE).

The distinctly tetragonal achenes, deeply and conspicuously rugose-convoluted on all faces, mark this species from all other Mexican ones. The development of a dense villous pubescence on the stems and around the bases of the leaf blades is also much more pronounced than in any other Mexican species.

3. **G. Robinsonii** Steyermark, sp. nov.[7]

Herbaceous; stems slender, mostly solitary, remotely and irregularly branched above with elongated arcuate-ascending or spreading monocephalous floriferous branchlets, buff to purplish-red, sparsely or moderately villous to villosulous, 1.5–4 dm. tall; leaves gradually reduced towards heads, scarcely resinous-punctate, rather subcoriaceous, closely crenate-serrate to regularly serrulate with short deltoid acute to acuminate teeth, 1–5 cm. long, 0.3–1.3 cm. broad, 1–5 times longer than broad, oblong to oblanceolate-spatulate, obtuse to obtusish, subamplexicaul or about as broad at the base as at the middle, those on floriferous branchlets ovate-oblong to oblong-lanceolate, obtuse to acute, amplexicaul or subamplexicaul, moderately scabridulous-hirsutulous; heads few, radiate, 1.6–2.2 cm. broad; disk campanulate-hemispherical, 0.7–1 cm. high, 1–1.6 cm. broad; involucral bracts about 4-seriate, 3–6.5 mm. long, linear- to broadly oblong-lanceolate with acute to acuminate short tips, the outer and middle apparently not resinous, the outer sparsely puberulous to glabrate, the others mostly glabrous; rays 15–20, dull yellow, lamina 5–7 mm. long; achenes broadly oblong or quadrate-oblong, light brown, turgid, compressed-subquadrangular, 2.5–2.6 mm. long, 1.5–1.7 mm. broad, slightly wrinkled when mature, horizontally truncate at apex; awns 2, nearly capillary, entire, 4–4.5 mm. long, equalling the length of disk-floret.

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[7] **G. Robinsonii** Steyermark, sp. nov., caule tenui, plerumque 1, supra remote et irregulariter ramoso cum ramusculis floriferis tenuibus elongatis arcuato-adscendentibus vel patentibus, parce vel moderatim villosis, 1.5–4 dm. altis; foliis adversum capitula gradatim reductis, contigue et regulariter serrulatis cum dentibus brevibus deltoideis acutis vel acuminatis, 1–5 cm. longis, 0.3–1.3 cm. latis, 1–5 plo longioribus quam latis, oblongo- vel oblanceolato-spathulatis, illis in ramusculis floriferis ovato-oblongis vel oblongo-lanceolatis, moderatim scabridulo-hirsutulis; capitulis paucibus, 1.6–2.2 cm. latis; disco 0.7–1 cm. alto, 1–1.6 cm. lato; bracteis involucri 3–6.5 mm. longis, lineari- vel late oblongo-lanceolatis cum apicibus brevibus acutis vel acuminatis; receptaculo parce foveolato; ligulis 15–20, 5–7 mm. longis, 1.5–2 mm. latis; achaeniis paullum rugulosis.—Collected at Agua del Medio, San Luis Potosi, Mexico, July, 1911, *Purpus 5722* (U. S. Nat. Herb. no. 464079 TYPE, G, M, NY, isotypes).

Distribution: State of San Luis Potosi, central Mexico.

MEXICO: SAN LUIS POTOSI—Minas de San Rafael, July, 1911, *Purpus 5151* (CAL, G); Agua del Medio, July, 1911, *Purpus 5722* (G, M, NY, US TYPE).

### 4. **G. Greenmanii** Steyermark, sp. nov.[8]

*G. inuloides* Willd. acc. to Wats. in Proc. Am. Acad. **18**: 101. 1883, as to plant of *Palmer 471*.

Herbaceous; stem with several erect-ascending corymbosely branched elongated monocephalous floriferous branchlets, brown or cinnamon, mixed glandular-puberulent, densely glandular, especially on floriferous branchlets, at least 5 dm. tall; leaves slightly reduced towards heads, scarcely resinous-punctate, firmly membranaceous, the upper regularly finely denticulate or serrulate with setulose acute teeth, 2–7 cm. long, 0.5–1.2 cm. broad, 3–6 times longer than broad, oblong-lanceolate to lanceolate, acuminate, subamplexicaul to amplexicaul, mixed densely glandular and puberulent; heads radiate, 3.5–4 cm. broad; disk depressed- or campanulate-hemispherical, 1.2–1.4 cm. high, 2.2–2.5 cm. broad; involucral bracts scarcely resinous, about 4-seriate, the upper half free and spreading to ascending, 8–11 mm. long, mostly linear to lanceolate with elongated subulate tips, minutely glandular; rays about 25, lamina 12–16 mm. long; achenes oblong, 2.5–3 mm. long, 1.5–1.7 mm. broad, compressed-subquadrangular or somewhat flattened, dull or dark brown, slightly roughened on convex outer portion, smooth on inner and lateral faces, horizontally truncate at apex; awns 2–3, nearly capillary, 5–7 mm. long, entire, equalling length of disk-floret.

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[8] **G. Greenmanii** Steyermark, sp. nov., caulibus corymboso-ramosis, glanduloso-puberulis, ramusculis floriferis dense glandulosis, elongatis, 5 dm. vel plus altis; foliis non bracteatis adversum capitula, firme membranaceis, illis in ramusculis floriferis regulariter et tenuiter denticulatis aut denticulato-serrulatis cum dentibus tenuibus setulosis, glanduloso-puberulis, elongatis, plerumque 2–7 cm. longis, capitula terminalia solitaria ferentibus; capitulis radiatis, 3.5–4 cm. latis; disco 1.2–1.4 cm. alto, 2.2–2.5 cm. lato; bracteis involucri patentibus vel adscendentibus, 8–11 mm. longis, exterioribus 8–9 mm. longis, submembranaceis, tenuibus, minute glandulosis; ligulis 12–16 mm. longis; achaeniis oblongis, 2.5–3 mm. longis, 1.5–1.7 mm. latis, parte exteriore convexa paullum rugulosa, ceteribus laevibus; aristis 5–7 mm. longis.—Collected at Lerios, State of Coahuila, Mexico, July 10–13, 1880, *Ed. Palmer 471* (Gray Herb. TYPE, PA, US, isotypes).

Distribution: mountainous region about Lerios, southeastern portion of State of Coahuila, northeastern Mexico.

MEXICO: COAHUILA—Lerios, 15 leagues east of Saltillo, July 10–13, 1880, *Ed. Palmer 471* (G TYPE, PA, US).

5. **G. grandiflora** Hook. Bot. Mag. III. **8:** *pl. 4628*. 1852, not of most American authors; Lindl. & Paxt. ex Paxt. Fl. Gard. **3:** 8. 1852–53; Walp. Ann. **5:** 191. 1858; Gray, Syn. Fl. N. Am. $\mathbf{1}^2$: 118. 1884, and ed. 2. 118. 1888, as name-bringing synonym; Small, Fl. Southeast. U. S. 1180. 1903, and ed. 2. 1180. 1913, as to name only.

*G. squarrosa* var. *grandiflora* (Hook.) Gray, Smithson. Inst. Contr. [Pl. Wright. pt. 1] $\mathbf{3}^5$: 98. 1852, as to name-bearing synonym only; Coult. in Contr. U. S. Nat. Herb. [Bot. W. Texas] **2:** 184. 1892, as to name-bearing synonym only.

*G. costata* Gray in Proc. Am. Acad. **17:** 208. 1882; Wats. in Proc. Am. Acad. **18:** 102. 1883; Gray, Syn. Fl. N. Am. $\mathbf{1}^2$: 117. 1884, and ed. 2. 117. 1888; Hemsl. Biol. Cent.-Am. Bot. **4:** 52. 1886.

Herbaceous biennial or annual; stems corymbosely much-branched above the middle with elongated simple monocephalous branches, glabrous, up to 1 m. tall; leaves somewhat reduced on flower-bearing branches, submembranaceous, dull green, not obviously resinous-punctate, finely and evenly crenulate, the upper sometimes entire, the basal cauline mostly lyrate or pinnatifid, acute to acuminate, linear to lanceolate-oblong, the upper lanceolate, the middle and upper cauline 4–6 cm. long, 0.8–1.5 cm. broad, those on the floriferous branches smaller, 1–3 cm. long, 3–7 mm. broad, 4–6 times as long as broad, subamplexicaul, glabrous; heads radiate, about 2.5 cm. broad; disk depressed-hemispherical, 10–14 mm. broad, 6–8 mm. high; involucral bracts 4–7.5 mm. long, linear to lanceolate, with

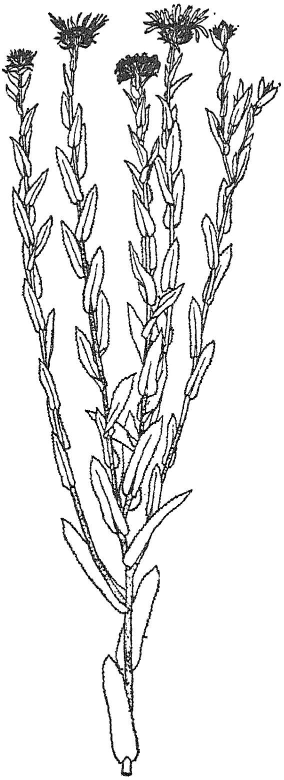

Fig. 4. *G. Greenmanii.* × ⅕.

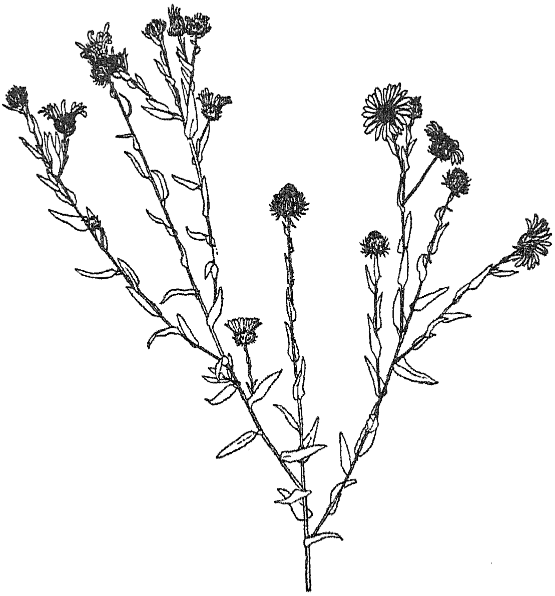

Fig. 5. *G. grandiflora.* × ⅕.

loose spreading to ascending filiform-subulate tips, submembranaceous, the free portion subterete, glabrous, innermost possessing some viscidity when young; receptacle inconspicuously foveolate; rays orange-yellow or golden, 17–26, the lamina 10–12 mm. long; achenes broadly oblong, 2–2.3 mm. long, 1.8–2 mm. broad, turgid, convexly rounded on the dorsal ends, brownish or stramineous, conspicuously costate with 9–10 ribs, 7–8 prominent and 2–3 smaller, obliquely truncate at apex; awns 2–4, nearly capillary, slightly dilated at the acute apex, remotely to numerously serrulate or setulose-serrulate, 3–4.5 mm. long, ⅔–¾ length of disk-floret.

Distribution: along river courses in arid rocky southwestern Texas in Valverde, Sutton, and Edwards Counties, to northern Coahuila, Mexico.

UNITED STATES: TEXAS—Ranch Experiment Station, Edwards Co., Oct. 6, 1932, *Cory 5013* (CO); 14 miles south of Sonora, Sutton Co., Sept. 16, 1932, *Cory 4896* (CO); cult. in Hort. Kew. from seeds collected in Texas by *Wright* (M photograph of TYPE); along Devil's River, Valverde Co., Sept. 13, 1900, *Eggert* (M); between the head of the San Pedro River and Live Oak Creek, Nov., 1851, *Schott 514* (F, G, NY).

MEXICO: Coahuila and Nuevo Leon, Feb.–Oct., 1880, *Ed. Palmer 472* (G TYPE of *G. costata*, PA, US).

An examination of the photograph of the type of *G. grandiflora* Hook. shows that it is not the plant which most American authors have identified as *G. grandiflora* (that proving rather to be *G. texana* Scheele), but that it is the rare species of southwestern Texas and adjacent northern Mexico which Gray described as *G. costata.* The conspicuously ribbed achenes of this species are very characteristic. The lamina of the ray-flowers are almost orange, quite different from the lemon-yellow color of most species of *Grindelia.*

6. **G. Nelsonii** Steyermark, sp. nov.[9]

Herbaceous; stems corymbosely branched above with elongated ascending floriferous branchlets, rose-purple to buff, glabrous to sparsely puberulent; leaves firmly membranaceous, scarcely resinous-punctate, dark green, becoming reduced and scattered towards the heads, closely crenulate-serrulate with shallow inconspicuous broad acute or slender obtuse teeth, 1–7.5 cm. long, 0.3–1.2 cm. broad, 2½–7 times longer than broad, linear or linear-oblong to (the upper) ovate-lanceolate, acute to acuminate, the upper subamplexicaul, glabrate to puberulent; heads radiate, 3–5 cm. broad; disk campanulate-hemispherical, 0.9–1.3 cm. high, 1.5–2.5 cm. broad; involucral bracts moderately resinous, 4-seriate, the upper ⅓–¼ free and spreading, 4–8 mm. long, lanceolate with acute to acuminate tips, the free portion flattened, subcoriaceous or firmly membranaceous, glabrous; receptacle moderately foveolate; rays 26–30, conspicuously elongated, orange-yellow, the lamina 17–22 mm. long, 3–3.5 mm. broad; achenes broadly oblong, subquadrangular, turgid, 3–4 mm. long, 2–2.3 mm. broad, smooth or slightly striate, light yellow or tawny brown, apex truncate, rounded and slightly thickened at the angles; awns 2–3, capillary-linear, entire, acute, 4–4.5 mm. long, about equalling length of disk-floret.

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[9] **G. Nelsonii** Steyermark, sp. nov., caulibus glabris vel parce puberulis; foliis firme membranaceis, atro-viridibus, contigue et regulariter crenulato-serrulatis cum dentibus latis acutis, 1–7.5 cm. longis, 0.3–1.2 cm. latis, 2½–7 plo longioribus quam latis, linearibus vel lineari-oblongis, vel (superioribus) ovato-lanceolatis; ligulis 26–30, elongatissimis, 17–22 mm. longis; aehaeniis laevibus vel paullum striatis.—Collected at Los Reyes, Michoacan, Mexico, Feb. 8–12, 1903, *E. W. Nelson 6864* (U. S. Nat. Herb. no. 399215 TYPE, G, NY, isotypes).

Distribution: Los Reyes, Michoacan, west-central Mexico.

MEXICO: MICHOACAN—Los Reyes, Feb. 8–12, 1903, *E. W. Nelson 6864* (G, NY, US TYPE).

7. **G. tenella** Steyermark, sp. nov.[10]

*G. inuloides* Willd. acc. to DC. Prodr. **5**: 315. 1836, as to plant of *Berlandier 766 (2186)*; acc. to Hemsl. Biol. Cent.-Am. Bot. **2**: 112. 1881, as to plant of *Berlandier 766 (2186)*.

*G. inuloides* Willd. var. *microcephala* Gray acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, as to plant from Mexico of *Berlandier 766 (2186)*.

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[10] **G. tenella** Steyermark, sp. nov., ramusculis floriferis adscendentibus capitula terminalia ferentibus, supra parce vel dense villosis vel villosiusculis; foliis capitula non subtendentibus, contigue et regulariter denticulatis vel denticulato-serrulatis cum dentibus setulosis oblongis resiniferis, oblanceolato-oblongis aut oblongis vel lanceolatis, plus minusve villosiusculis vel hirtellis; disco 0.6–0.9 cm. alto, 0.9–1.3 cm. lato; achaeniis quadrato-oblongis, subquadrangularibus, 1.8–2 mm. longis, 1–1.8 mm. latis, rugosis; aristis 2, integris, acutis.—Collected from Victoria to Tula, State of Tamaulipas, Mexico, Nov., 1830, *Berlandier 766 (2186)* (Gray Herb. TYPE, NY isotype).

Herbaceous; stems slender, cinnamon-buff to bay, branched with long ascending floriferous branchlets, bearing mostly solitary small terminal heads, glabrous or glabrate below, sparsely to densely villous or villosulous above, at least 4 or more dm. tall; leaves only slightly reduced on floriferous branchlets, scarcely resinous-punctate, submembranaceous to firmly membranaceous, dark green, regularly denticulate to denticulate-serrulate with fine shallow to mostly salient setulose or oblong, acute or obtuse, resin-tipped teeth up to 1.5 mm. long, 1.5–5 cm. long, 0.5–1.1 cm. broad, oblanceolate-oblong or oblong to lanceolate, obtuse to acute, subamplexicaul, or about as broad at base as at middle, rather closely villosulous or hirtellous; heads radiate, 2–2.5 cm. broad; disk campanulate-hemispherical, 0.6–0.9 cm. high, 0.9–1.3 cm. broad; involucral bracts scarcely resinous, 3.5–6.5 mm. long, linear- to lanceolate-subulate with elongated subulate tips, upper ½–⅔ free and arcuate-spreading or ascending, subterete, firmly membranaceous, sparsely puberulent to glabrate; rays 15–18, lamina 7–9

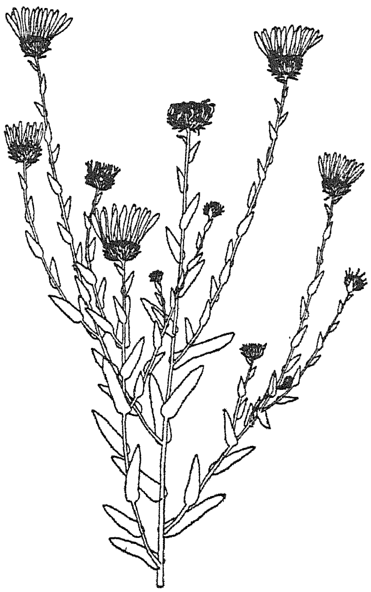

Fig. 6. *G. Nelsonii.* × ⅕.

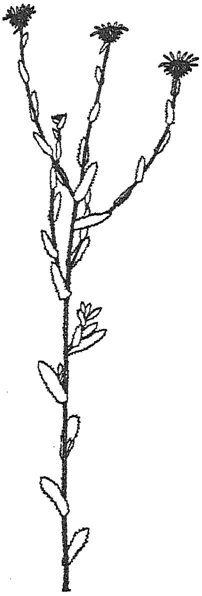

Fig. 7. *G. tenella.* × ⅕.

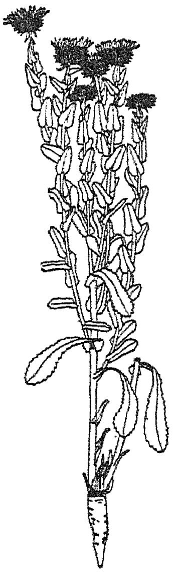

Fig. 8. *G. Palmeri.* × ⅕.

*1542*; Hook. Bot. Mag. N. S. **13**: *pl. 3737*. 1840; acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, as to plants from Texas *(Lindheimer 255, Drummond 131,* and *Reverchon)*; Coult. in Contr. U. S. Nat. Herb. [Bot. W. Texas] **2**: 184. 1892; acc. to Small, Fl. Southeast. U. S. 1180. 1903, and ed. 2. 1180. 1913.

Stems stoutish, usually one from an herbaceous base, corymbosely branched above with several conspicuously elongated floriferous branchlets bearing several heads, stramineous to Indian-purple, sparsely hirtellous to glabrate below, moderately to densely hirtellous to villosulous above, eglandular, 0.35–1.3 m. tall; leaves not reduced, subtending the heads, the upper and often the middle cauline very evenly and finely denticulate with short conspicuous setulose resin-tipped teeth, the upper cauline and those on floriferous branchlets 2–5 cm. long, 0.6–2.5 cm. broad, 1⅓–3¾ times longer than broad, the lower and middle cauline 4.5–9 cm. long, 1.5–3 cm. broad, 3–4 times longer than broad, middle and upper subpandurate-oblong to oblong- or ovate-lanceolate, acute to ob-

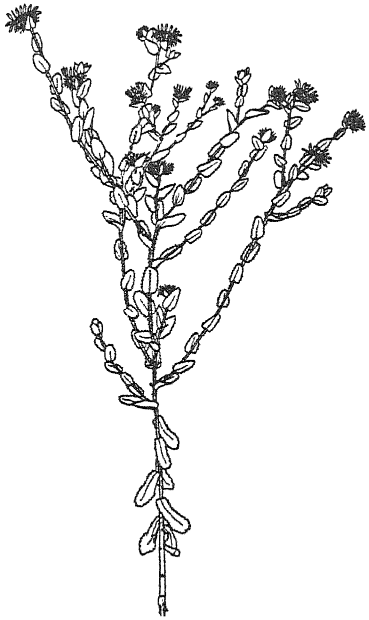

Fig. 9. *G. microcephala.* × ⅕.

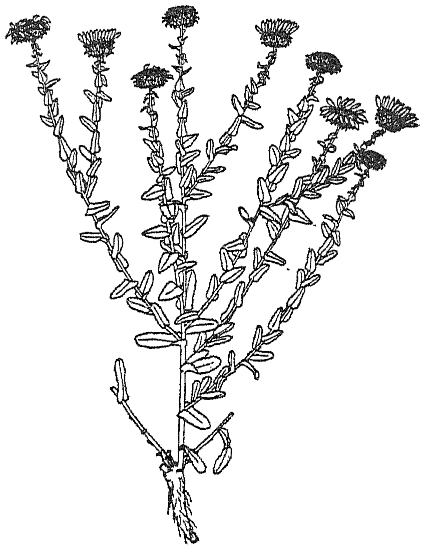

Fig. 10. *G. subdecurrens.* × ⅕.

tusish, abruptly apiculate, the base broadly ampliated and strongly amplexicaul, scabridulous or hirtellous, or becoming glabrate; heads 1.7–3 cm. broad; disk 0.8–1.2 cm. high, 1–2 cm. broad; rays 20–27, lemon-yellow, 8–12 mm. long, 2.5–3.2 mm. broad; achenes depressed-rhomboid, 3–4-ribbed, the convex third side with the angles and sometimes the middle longitudinally ribbed, turgid, the angles corky-thickened, the faces between the angles conspicuously rugose-wrinkled, 3–4.3 mm. long, 2.0–3.5 mm. broad, truncate at the rounded and thickened apex; awns 2 to floret, mostly dilated at apex, acute, 5–6 mm. long, equalling or slightly surpassing length of disk-floret, straight.

Distribution: bottomlands, rich low ground and thickets, and near rivers, north-central Texas near Dallas and Ft. Worth, south to vicinity of San Antonio and Industry, south-central Texas.

TEXAS: 39 miles west of San Felipe, Juli–Aug., 1844, *Lindheimer 255* (CAL, G, M TYPE, PA); expedition from western Texas to El Paso, N. Mex., May–Oct., 1849, *Wright 297* (G, NY); S. Felipe de Austin, Hooker misit, Januar, 1835, *Drummond 131* (G); 3 mi. west of San Marcos, Hays Co., June 8, 1931, *Moore & Steyermark 3000* (M); in sandy loam near Guadalupe River, Seguin, Aug. 18, 1903, *Groth 198* (F, G, NY, US); Ft. Worth, Aug. 1, 1926, *Killian 6572* (UT); rich low lands, Dallas Co., July, *Reverchon* (Curt. distr. no. 1368 b) (CAL, F, M, MU, PA); rich black soil, Bastrop Co., summer 1926, *Duval 307* (UT); tropical life zone, San Antonio, Bexar Co., June 20, 1911, *Mr. & Mrs. J. Clemens 948* (CAS, M, PO, R, US); open ground, along river, Sabinal, Uvalde Co., June 8, 1916, *E. J. Palmer 10134* (M); on prairies near Cox's Point, Calhoun Co., Aug. 12, 1920, *Drushel 4165* (M); Calvert, Aug., 1888, *Pammel* (M); Corpus Christi, Nueces Co., May 11, 1900, *Bailey 256a* (US); Corpus Christi, 1889, *Nealley 305* (US); Keller's Point, Sept. 7, 1922, *Tharp 1633* (US, UT); in a deep depression near T. & P. R. R., near Ft. Worth, Sept. 2, 1912, *Ruth 284* in part (G, M, NY, PA, US); rich low thickets, Dallas, Aug. 1882, and in Trinity Bottom, near Dallas, Aug., 1882, *Letterman* (M, NY, PA, US); Comanche Spring, New Braunfels, etc., July, 1851, *Lindheimer 919* (CAL, F, G, M, NY, PA, US, UT); Cleburne, June 19, 1930, *Whitehouse* (UT); sandy soil, Fort Bunggold, Starr Co., alt. 400 ft., April 25, 1925, *Runyon 841* (US); roadside, 5 mi. s. of San Antonio, May 16, 1920, *Schulz 532* (US).

### 8c. var. **adenodonta** f. **angustior** Steyermark, f. nov.[13]

Stems as tall as the variety, more glabrate in lower half, eglandular; middle and upper cauline leaves less subpandurate-oblong, less ampliated at base, sometimes no broader or even narrower at the base than at the middle, the crenulate serrulations shallower and somewhat broader, the main cauline 4–10 cm. long, 0.7–2 cm. broad, 4–7 times longer than broad, spatulate-oblong to oblong-oblanceolate, acute to obtuse, those on floriferous branchlets subpandurate-oblong to narrowly oblong, smaller and not so conspicuous subtending the heads as in the variety.

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[13] **G. microcephala** var. **adenodonta** f. **angustior** Steyermark, f. nov., foliis caulinis mediis et superioribus minus subpandurato-oblongis quam varietate, ad basem minus ampliatis, dentibus paullo latioribus et brevioribus, caulinis principalibus 4–10 cm. longis, 0.7–2 cm. latis, spathulato-oblongis vel oblongo-oblanceolatis, capitula minus conspicue subtendentibus.—Collected in rocky open ground along small streams, near Uvalde, Uvalde Co., Texas, April 28, 1928, *E. J. Palmer 33590* (Mo. Bot. Gard. Herb. no. 945114 TYPE, NY isotype).

Distribution: eastern limits of mesquite chaparral country near the Rio Grande region, in rocky open ground along stream, dry open fields adjacent to mesquite chaparral, or in dry soil of mesquite pastures, Bexar, Uvalde, Medina, Maverick, and Dimmit Counties, south-central Texas.

TEXAS: rocky soil, mesquite pasture, Bexar Co., June 10, 1919, *Schulz 106* (US); dry open field adjacent to mesquite chaparral, 3 mi. east of Hondo, Medina Co., alt. 240 m., June 8, 1931, *Moore & Steyermark 3003* (M); dry open field, ½ mi. west of Uvalde, Uvalde Co., alt. 250 m., June 8, 1931, *Moore & Steyermark 3004* (M); gumbo soil in chaparral, 10 mi. west of San Antonio Bexar Co., alt. 229 m., June 8, 1931, *Moore & Steyermark 3002* (M); Eagle Pass, April 27, 1931, *M. E. Jones 28037* (M); Carriso Spring, April 26, 1931, *M. E. Jones 28036* (CAL, M); rocky open ground along small stream, near Uvalde, Uvalde Co., April 28, 1928, *E. J. Palmer 33590* (M TYPE, NY isotype); Alpine, April 29, 1928, *E. J. Palmer 33590* (B).

**8d.** var. **montana** Steyermark, var. nov.[14]

Stems tall and branching as in the var. *adenodonta* but rather closely mixed glandular and villosulous; leaves mixed glandular-scabridulous or hirtellous, the middle and upper cauline serrulate with broader more deltoid coarser more acute teeth; disk about 2–2.1 cm. broad, 1.1–1.3 cm. long; awns 4.2–4.5 mm. long, acuminate to a slender apex.

Distribution: mountains, San Juan del Estado, State of Oaxaca, Mexico.

MEXICO: mountains, San Juan del Estado, State of Oaxaca, alt. 7500 ft., Aug. 13, 1894, *L. C. Smith 135* (G TYPE).

This species, with its varieties, has been identified by most authors as *G. inuloides*, and Gray considered *G. microcephala* DC., not Rothr., as only a variety of *G. inuloides;* however, as shown in a previous section under *G. inuloides, G. inuloides*

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[14] **G. microcephala** var. **montana** Steyermark, var. nov., foliis et caulibus glanduloso-villosiusculis, ceterum ut apud var. *adenodontam.*—Collected in mountains, San Juan del Estado, State of Oaxaca, Mexico, alt. 7500 ft., Aug. 13, 1894, *Rev. L. C. Smith 135* (Gray Herb. TYPE).

Willd. is a strictly Mexican species. The Texas species passing as *G. inuloides* becomes *G. microcephala* DC. and var. *adenodonta.* The more widely distributed and commoner form is the var. *adenodonta,* a variety which passes into the historical type plant, an uncommon form limited to the coastal region of south-central Texas in the vicinity of Corpus Christi and Rio Frio, and described as *G. microcephala* DC. Towards the western and southwestern limit of dispersal *G. microcephala* var. *adenodonta* is replaced by a forma *angustior* with narrower middle and upper cauline leaves, which are less ampliated and amplexicaul at the base and less finely and evenly setulose-denticulate.

This species and varieties bloom earlier than any of the other species of Texas, the usual period of anthesis being from May to June.

9. **G. Palmeri** Steyermark, sp. nov.[15]

*G. inuloides* Willd. acc. to Gray, Syn. Fl. N. Am. 1²: 117. 1884, and ed. 2. 117. 1888, as to plants from Mexico, in part only (*Parry & Palmer 371).*

Herbaceous; stems corymbosely branched with several elongated erect-ascending to substrict stout monocephalous floriferous branchlets 1.5–3 dm. long, buff to light brown or suffused with reddish-purple, glabrous below, mostly sparsely villous towards the heads, 3–5 dm. or more tall; leaves gradually reduced towards heads, scarcely resinous-punctate, submembranaceous or firmly membranaceous, upper leaves regularly serrulate-denticulate or crenulate-serrulate with short broadly oblong to deltoid, obtuse to acute serrulations, 1.5–6 cm. long, 0.8–1.5 cm. broad, oblanceolate-spatulate to (the upper) ovate or broadly oblong, obtuse to acute, amplexicaul to (the upper) subcordate, glabrate to sparsely puberulent; heads radiate, 3–4 cm. broad; disk depressed-hemispherical, 0.8–1 cm. high, 1.6–2.2 cm. broad; involucral bracts mostly not resinous, 4–5-seriate, 4–9 mm. long, linear-lanceolate to lanceolate with gradually acuminate or subulate tips, glabrous, the outer and middle bracts elongated, subequal, the upper ½–⅓ free and spreading, flattened, firmly membranaceous; receptacle moderately foveolate; rays 25–35, lamina 10–13 mm. long, 2.5–3 mm. broad; achenes oblong, 2.5–3 mm. long, 1.3–1.7 mm. broad, dark brown, smooth to slightly wrinkled or finely verruculose, horizontally truncate at apex; awns 2–4, 5 on some ray-florets, nearly capillary, entire, acute, 3.5–5.5 mm. long, equalling length of disk-floret.

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[15] **G. Palmeri** Steyermark, sp. nov., caulibus corymboso-ramosis, ramusculis floriferis erecto-adscendentibus vel substrictis, capitula terminalia solitaria ferentibus, infra glabris, adversum capitula plerumque parce villosis, 3–5 plus dm. altis; foliis adversum capitula non bracteiformibus et non remotis, parce resinoso-punctatis, plus minusve submembranaceis vel firme membranaceis, regulariter serrulato-denticulatis vel crenulato-serrulatis, dentibus brevibus sed salientibus, late oblongis, 1.5–6 cm. longis, 0.8–1.5 cm. latis, ovato-oblongis vel ovatis vel late oblongis, obtusis vel acutis, glabratis vel parce puberulis; bracteis involucri glabris; achaeniis 2.5–3 mm. longis, 1.3–1.7 mm. latis, laevibus vel paullum rugulosis vel minute verruculosis; aristis 3.5–5.5 mm. longis.—Collected at Alvarez, State of San Luis Potosi, Mexico, Sept. 28–Oct. 3, 1902, *Ed. Palmer 163* (U. S. Nat. Herb. no. 397709 TYPE, G, M, NY, isotypes).

Distribution: States of San Luis Potosi and Queretaro, central Mexico.

MEXICO: SAN LUIS POTOSI—in the region of San Luis Potosi, 22° N. Lat., alt. 6000–8000 ft., 1878, *Parry & Palmer 371* (G, M, PA, US); Alvarez, Sept. 28–Oct. 3, 1902, *Ed. Palmer 163* (G, M, NY, US TYPE).

10. **G. subdecurrens** DC. Prodr. **5**: 315. 1836; Steud. Nom. Bot. ed. 2. **1**: 708. 1840; Hemsl. Biol. Cent.-Am. Bot. **2**: 113. 1881; Gray in Proc. Am. Acad. **17**: 208. 1882; Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as synonym.

*G. squarrosa* (Pursh) Dunal var. *hirtella* Rob. & Greenm. in Am. Jour. Sci. **50**: 153. 1895.

Herbaceous; stems mostly several, corymbosely branched near or below the middle with slender divaricate branchlets bearing several to many heads, light brown to suffused with purplish or reddish purple, glabrate, puberulent, or mixed glandular-puberulent, 2–6 dm. tall; leaves gradually reduced towards heads, slightly or moderately resinous-punctate, subcoriaceous and firm, closely obtusely serrulate to crenulate-serrulate, the small teeth mostly resinous-tipped, 1–6 cm. long, 0.4–1.7 cm. broad, 2–4 times longer than broad, narrowly oblong to (the upper) ovate-oblong, obtuse, subamplexicaul to (the upper) subcordate, those near heads lanceolate-deltoid to deltoid-ovate with abruptly subulate or caudate tips, glabrous, glandular, or mixed glandular-puberulent; heads radiate, 1.7–3 cm. broad; disk depressed-hemispherical, the sides rather distending downwards in fruit, 0.8–1 cm. high, 1.3–2.5 cm. broad; involucral bracts moderately and rather conspicuously resinous, 4–6-seriate, 2.5–8 mm. long, mostly green throughout, glabrous, glandular or puberulent, upper ⅕–⅔ free and loosely reflexed to somewhat recurved, subterete, thickened, subcoriaceous, with short tips 1–4 mm. long, the outer linear- to oblong-lanceolate with subulate or acuminate tips, the outermost reflexed at base of involucre; receptacle conspicuously foveolate; rays 20–30, dull orange-yellow, lamina 5–11 mm. long; achenes broadly oblong and subturgid, compressed-subquadrangular, 2.8–4 mm. long, 1.5–2.1 mm. broad, light to dark brown, irregularly shallowly wrinkled when mature, horizontally truncate at apex; awns 2–3 to the floret, capillary-linear, entire to remotely marked in upper half with few short teeth, mostly attenuate to slender-acuminate apex, 3–5 mm. long, equalling length of floret, straight.

Distribution: hills and slopes between 5000 and 7500 ft. alt., Villalpando, State of Guanajuato, south-central Mexico and south in western Oaxaca, southern Mexico.

MEXICO: SAN LUIS POTOSI—ex convalli San Luis Potosi, in umbrosis prope Penosio, Aug., 1876 and 1877, *Schaffner 309* (G, NY); GUANAJUATO—''Villalpando au . . . . . de Guanatnato,'' 1829, *Mendez* (G isotype, CAL fragment of TYPE, CAL, G, US photograph of TYPE); OAXACA—La Carbonera, alt. 1600 m., Aug., 1897, *Conzatti & Gonzalez 388* (G); La Carbonera, Distrito de Etla, alt. 2200 m., June 28, 1920, *Conzatti 4014* (US); La Carbonera, alt. 7000 ft., Sept. 20, 1895, *L. C. Smith 803* (G); hills, Las Sedas, alt. 6000 ft., Aug. 16, 1894, *Pringle 4805* (CAL, G, M, MA, MU, NY, PA, US); Las Sedas, Distrito de Etla, Oct. 10, 1933, *Conzatti 4999* (M).

From *G. inuloides* Willd., with which it has sometimes been confused, *G. subdecurrens* DC. may be distinguished by the conspicuous balsamic-resinous heads, and by the more resinous-punctate, firmer and more subcoriaceous leaves with regularly and obtusely crenulate-serrulate margins. Further, the mature achenes in *G. subdecurrens* are shallowly wrinkled on the faces, whereas in *G. inuloides* the surface is smooth or, at most, slightly striate.

*Grindelia squarrosa* var. *hirtella* Rob. & Greenm. has been found to be synonymous with *G. subdecurrens,* and although Robinson and Greenman treated their plant as only an hirtellous variety of *G. squarrosa,* specific differences between the two are quite manifest. From *G. squarrosa, G. subdecurrens* (*G. squarrosa* var. *hirtella*) is at once distinguished by its more nearly capillary subentire pappus awns, shallowly wrinkled achenial surfaces, puberulent or villosulous stems (at least above), and by the leaves, which are much more reduced towards the heads and more attenuate-caudate at the apex. Other points of difference are that *G. subdecurrens* has shorter stems than *G. squarrosa,* and its leaves have a decidedly dark forest-green caste, whereas those of *G. squarrosa* are duller or more bluish- or grayish-green.

11. **G. Havardii** Steyermark, sp. nov.[16]

*G. squarrosa* var. *grandiflora* (Hook.) Gray, Syn. Fl. N. Am. 1²: 118. 1884, and ed. 2. 118. 1888, as to plant of *Wright* only, not plants of *Berlandier, Lindheimer,* and *Reverchon.*

*G. squarrosa* (Pursh) Dunal acc. to Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19:** 655. 1915, as to plant from west of Roswell, N. Mex.

Apparently biennial; stems stoutish, one to several from a subherbaceous base, corymbosely branched above with divaricate to spreading-ascending elongated floriferous branchlets bearing several to many heads, ochraceous-buff, light pinkish-cinnamon to stramineous, glabrous to minutely glandular-puberulent, 3–9 dm. tall; leaves gradually reduced on flowering branchlets, moderately resinous-punctate, firmly subcoriaceous, dark green, the main cauline serrate or dentate with shallow or salient, obtuse to sharply acute teeth, those on floriferous branchlets mostly closely crenate-dentate with conspicuous obtuse resinous-tipped teeth, sometimes sharply serrate with sharply acute teeth, 0.7–5.5 cm. long, 0.4–2.2 cm. broad, oblong to (the upper) ovate, acute to acuminate, subamplexicaul to amplexicaul, glabrous to rather closely scabridulous; heads radiate, 2.5–3 cm. broad; disk depressed-hemispherical, 0.8–1.3 cm. high, 1.2–2.2 cm. broad; involucral bracts abundantly resinous, 5–6-seriate, 4–10 mm. long, linear to lanceolate with gradually acuminate to subulate subcoriaceous tips, glabrous, the upper ½–⅔ free and spreading or squarrose, the outermost at base of involucre sometimes crowded and reflexed or descending; rays 18–25, dull yellow or lemon-yellow, rather narrowly oblong, obtuse, the lamina 9–11 mm. long, 2.5–3 mm. broad; achenes narrowly oblong, stramineous to light brown, 3–3.5 mm. long, 1–1.5 mm. broad, smooth, shining, compressed, horizontally truncate at apex; awns 2 to the floret, entire or remotely serrulate, 4–7 mm. long, slender, slightly dilated to an acute apex, equalling length of disk-floret, straight.

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[16] **G. Havardii** Steyermark, sp. nov., caulibus glabris vel minute et moderatim glanduloso-puberulis, 3–9 dm. altis; foliis firme subcoriaceis, caulinis principalibus serratis vel dentatis cum dentibus brevibus vel salientibus, obtusis vel salienter acutis, illis in ramusculis floriferis plerumque contigue et regulariter crenato-dentatis vel crenato-serratis cum dentibus resiniferis obtusis, 0.7–5.5 cm. longis, 0.4–2.2 cm. latis, 2–3 plo longioribus quam latis, caulinis inferioribus et mediis oblongis vel deltoideo-ovatis, amplexicaulibus vel subamplexicaulibus, glabris vel minute scabridiusculis; involucro abundanter resinoso, 5–6-seriato, bracteis exterioribus et mediis cum parte superiore ½–⅔ libera, patentibus vel squarrosis; aristis integris vel remote serrulatis, 4–7 mm. longis, disci flores aequantibus.—Collected on dry gravelly wash near mouth of McKittrick Canyon, Guadalupe Mountains, Culberson Co., Texas, alt. 2000 ft., July 23, 1931, *Moore & Steyermark 3607* (Mo. Bot. Gard. Herb. no. 1031229 TYPE).

Distribution: along dry gravelly washes, dry stream beds, rocky stream courses, and occasionally in fields near streams, southeastern New Mexico in vicinity of Roswell, Chaves Co., south along the eastern edge of Rocky Mountain escarpment in the Guadalupe and Chisos Mountains of western Texas, east to Devil's River, Valverde Co., and Big Spring, Howard Co., western Texas.

TEXAS: "western Texas to El Paso, N. Mex.," May–Oct., 1849, *Wright 296* (G, US); Rio Bravo del N., Rio San Pedro, *Schott* (NY); dry gravelly wash near mouth of McKittrick Canyon, Guadalupe Mts., Culberson Co., alt. 2000 m., July 23, 1931, *Moore & Steyermark 3607* (M TYPE); open valley, Nail Place, Chisos Mts., Aug., 1916, *Young* (UT); Secor River, Sept., 1881, *Havard 63* (NY, US).

NEW MEXICO: dry field, Black River, Eddy Co., Aug. 12–20, 1924, *Standley 40439* (US); 20 mi. west of Roswell, July 28, 1905, *Wooton* (NY, US); 35 mi. west of Roswell, Chaves Co., alt. about 3800 ft., Aug., 1900, *F. S. & E. S. Earle 509* (M, NY); 35 mi. west of Roswell, Aug. 29, 1900, *F. S. & E. S. Earle 571* (M, MU, NY, US).

This species may be considered intermediate between *G. subdecurrens* and *G. squarrosa*. It has been derived from the more ancient Mexican *G. subdecurrens* stock, on the one hand,

and has given rise, on the other, to the *G. squarrosa* group. *Grindelia Havardii,* with a trace of minute puberulence or glandularity of the stems and leaves, loosely spreading involucral bracts, mostly ovate to deltoid-ovate uppermost leaves, and the usually subentire pappus awns, recalls some characteristics of *G. subdecurrens*, while its taller stems, large heads, paleaceous pappus awns, and smooth achenes are characters found in *G. squarrosa*.

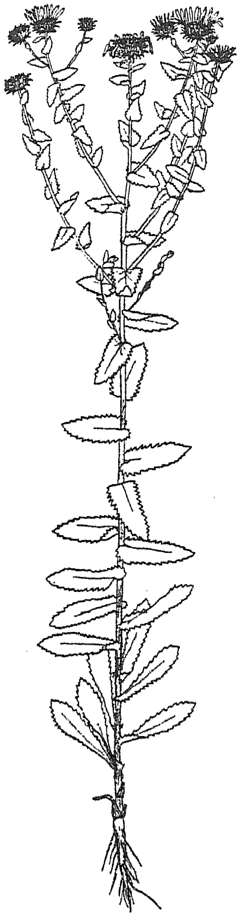

Fig. 11. *G. Havardii.* × 1/5.

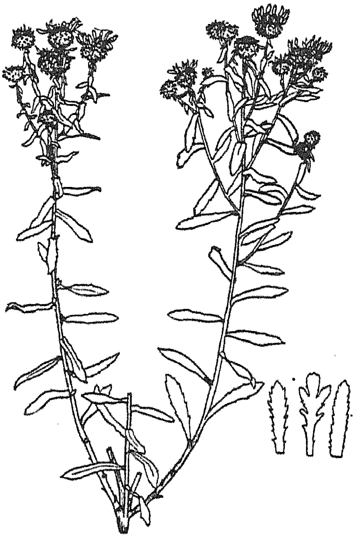

Fig. 12. *G. perennis.* × 1/5.

**12. G. squarrosa** (Pursh) Dunal in Mem. Mus. Par. **5**: 50. 1819; DC. Prodr. **5**: 315. 1836; Torr. & Gray, Fl. N. Am. **2**: 247. 1842, as to name mostly and synonymy in part, excluding most of range given; Wats. Bot. U. S. Geol. Expl. 40th Par. [Bot. King's Exp.] **5**: 163. 1871, as to name only; Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 118. 1888, in part only; Britt. & Brown, Ill. Fl. N. States **3**: 321. 1898, and ed. 2. **3**: 371. 1913; Small, Fl. Southeast. U. S. 1180. 1903, and ed. 2. 1180. 1913, mostly as to name, excluding description as to "leaf-blades . . . spinose-serrate"; Rob. & Fern. in Gray's New Man. Bot. ed. 7. 786. 1908; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909, in small part, and excluding plants from Mexico; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915, as to name only; Rydb. Fl. Rocky Mts. 848. 1917, excluding plants from Saskatchewan and Arizona; Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 535. 1925, mostly as to name only, and excluding *G. serrulata;* Rydb. Fl. Pr. & Pl. Cent. N. Am. 784. *fig. 547.* 1932, excluding plants from Arizona and N. Dakota.

*Donia squarrosa* Pursh, Fl. Am. Sept. **2**: 559. 1814; Sims, Bot. Mag. **41**: *pl. 1706.* 1815; Nutt. Gen. N. Am. Pl. **2**: 163. 1818; Eaton, Man. Bot. N. Am. ed. 6. 127. 1833, and ed. 7. 281. 1836; Hook. Fl. Bor. Am. **2**: 25. [1834] 1840, as to name only, excluding plants of *Richardson, Drummond,* and *Douglas;* Eaton & Wright, N. Am. Bot. ed. 8. 227. 1840.

*Aurelia amplexicaulis* Cass. Dict. Sci. Nat. **37**: 468. 1825.

*G. squarrosa* var. *grandiflora* (Hook.) Gray acc. to Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 118. 1888, as to description in part as to "upper leaves . . . with . . . obtuse teeth."

*G. nana* Nutt. acc. to Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 556. 1906, as to plants of *Horner 566* and *Hardwick* only.

Biennial, or sometimes perennial in cultivation; stems often solitary from an herbaceous base, stout, corymbosely branched usually above the middle with strongly divergent many-flowered branchlets, usually white to stramineous or occasionally suffused with rose-purple, glabrous, mostly 0.4–1 m. tall, uniformly leafy throughout; leaves typically thick and subcoriaceous, dark, drab- or bluish-green, conspicuously and abundantly punctate, especially the middle and upper cauline and those on floriferous branchlets closely and evenly saliently crenulate-serrate, with obtuse resiniferous teeth projecting obliquely outwards, the main middle and upper cauline 3–7 cm. long, typically 1.0–2 cm. (sometimes 0.7–1 cm.) broad, mostly 2–4 times longer than broad, ovate- to pandurately or broadly oblong to (the lower) obovate- or spatulate-oblong, mostly obtuse or acutish, somewhat apiculate, strongly amplexicaul, glabrous; heads radiate, numerous, mostly 2.2–3.2 cm. broad; disk depressed, quadrate-hemispherical, the receptacle conspicuously distending downward and outward in fruit, becoming then horizontally subreniform, mostly 0.6–1.1 cm. high, 1.2–2 cm. broad; involucral bracts conspicuously and abundantly resinous, 5–6-seriate, the upper ½ to ⅔ free and loosely squarrose to moderately or even strongly reflexed, the outer loose mostly throughout the length, crowded and strongly descending or downwardly deflexed, usually 4–9 mm. long, linear, lanceolate-linear, to (the inner) lanceolate-subulate, with mostly subterete subcoriaceous tips; receptable conspicuously foveolate; rays typically 24–36, narrowly oblong-elliptic or oblanceolate, acutish, lemon-yellow to bright yellow, lamina 8–10 mm. long, 1.5–2.5 mm. broad; achenes quadrate-oblong, 2.3–3 mm. long, mostly 1–1.5 mm. broad, light brown to stramineous, striated about the angles, horizontally truncate at apex; awns frequently 2–3, or as many as 6, slender, acutish, subentire to moderately serrulate or setulose-serrulate, 3–5 mm. long, about ¾–⅞ length of disk-floret.

Distribution: indigenous to the central prairie and plains region from southern Minnesota and South Dakota south into southeastern Wyoming, Iowa, Nebraska, Kansas, and Texas, where it may also occur as a weed in pastures, fields, or along roadsides; also introduced elsewhere eastward and westward.

UNITED STATES:

MAINE: Portland, July 19, 1910, *Stubbs* (G).

VERMONT: open field, Brandon, Sept. 8, 1920, *Dutton* (CAR).

MASSACHUSETTS: Sherborn, Aug. 2, 1910, *Loomis* (G); Worcester, Sept. 10, 1913, *Horr* (G); Chatham, Aug., 1919, *Lawton* (G).

RHODE ISLAND: waste, Providence, Aug. 27, 1892, *Collins* (G).

NEW YORK: Millburn, Long Island, Aug. 2, 1896, *John* (PA); Patterson, Sept., 1911, *Pendleton* (NY).

NEW JERSEY: near Swedesboro, July, 1895, *Lippincott* (NY, PA).

PENNSYLVANIA: Chestnut Hill, Lancaster Co., Aug., 1917, *Urban* (NY); seashore, at North East, Erie Co., Aug. 22, 1908, *Patterson* (CAR).

DELAWARE: sandy field, near Milton, Aug. 17, 1899, *Commons* (G, PA).

MARYLAND: field east of Pres. Silvester's House, College Park, July 29, 1903, *Norton* (M).

DISTRICT OF COLUMBIA: mouth of Hunting Creek, July 30, 1916, *Layton* (US).

VIRGINIA: New Alexandria, Fairfax Co., Aug. 13, 1910, *Pennell 2581* (PA); roadside, Alexandria, Alexandria Co., July 31, 1904, *Dowell 3050* (M).

OHIO: in newly seeded alfalfa field, Jersey, July 29, 1909, *Condit* (CAL).

MICHIGAN: roadside, Grande Traverse Co., Aug. 24, 1919, *McAtee 3081* (US); Zoo Park, Oakland Co., Aug. 9, 1916, *Chandler* (US).

INDIANA: frequent as a weed in a very sandy fallow field about ¾ mi. southeast of Ontario, Lagrange Co., July 12, 1922, *Deam 36846* (D, G, NY, PA, US).

WISCONSIN: Dresser Junction, Polk Co., Aug. 15, 1900, *Baker* (G, PO); C. M. & St. P. R. R. track, on bay near junction, Madison, June 24, and Aug. 13, 1889, *Trelease* (M).

ILLINOIS: roadside, Evanston, Aug. 16, 1911, *Sherff* (G, M, US); sandy banks of Mississippi, opposite St. Louis, Aug., 1842, *Engelmann* (M).

MINNESOTA: Ada, Sept. 3, 1920, *Hanson* (PO); sandy prairies, Brainerd, Aug., 1891, *Sandberg* (MU); dry prairies, near Minneapolis, Aug., 1894, *Anderson* (MU).

IOWA: Ames, Aug., 1904, *Pammel 38* (G, M, NY, US); dry ground, Lee Co., Aug. 24, 1892, *Bush* (M); Council Bluffs, Sept. 10, 1909, *Somes 3277* (US); Moscow, Aug. 26, 1909, *Somes 3712* (US).

MISSOURI: pastures, dry slopes south of Hannibal, Marion Co., Oct. 9 and 12, 1916, *Davis 5780* (CAL, M, R, UT); introduced, Kansas City, Aug. 29, 1906, *Bush 4093* (G, M, NY, US); near Pacific, 1899, *Letterman* (M, US); sandy banks of Mississippi, St. Louis, Aug., 1842, *Engelmann* (G); Carroll Co., Sept. 18, 1890, *Bush* (MO).

ARKANSAS: sandy banks of Arkansas River, 20 miles above Little Rock, Aug., 1835, *Engelmann* (M); Little Rock, June, 1835, *Leyden* (M).

SOUTH DAKOTA: prairies in the camp near the old Maha village, Aug. 17, 1804, *Lewis & Clark* (PA TYPE); Brookings, Sept., 1893, *Thornber* (M).

NEBRASKA: Long Island, Omaha, Aug. 20, 1898, *Williamson* (PA); Crete, Sept., 1885, *Seigerist* (MU); waste places, Otoe Co., Aug. 15, 1898, *Fitzpatrick* (G); Callaway, Sept. 7, 1902, *Bates 2592* (G); Red Cloud, Aug. 5, 1907, *Bates* (MU); Imperial, Aug. 8, 1912, *Pool & Folsom* (UW).

KANSAS: Lawrence, Aug., 1884, *Oyster 3537* (F, M, NY); prairie, Riley Co., Sept. 25, 1895, *Norton 218* (G, M, NY, R, US); prairies, Topeka, Sept. 16, 1890, *Smyth 324* (NY, US); Tribune, Greeley Co., Aug. 13, 1892, and Aug. 26, 1898, *Reed* (CAL, N).

TEXAS: rocky bluffs, Archer and Baylor Co., Sept., 1879, *Reverchon 30* (G, NY); rich land, Archer Co., Sept., 1879, *Reverchon 471* (M); sandy plains, Graham, Oct. 29, 1902, *Reverchon* (M).

WYOMING: western foothills, Newcastle, July 9, 1927, *Hayward 2013* (R); Fort Laramie, Aug. 18, *Hayden* (M); Fort Laramie, Sept. 19, 1859, *H. Engelmann* (M); Laramie, Sept. 6, 1898, *A. Nelson 5281* (G, M, N, NY, R, US).

COLORADO: Denver, Sept., 1888, *Eccles* (NY); 1 mi. w. of Firstview, Cheyenne Co., alt. 1375 m., Aug. 31, 1931, *Moore & Steyermark 3786* (M).

IDAHO: shores of Lake Pend d'Oreille, alt. 650 m., Oct. 1, 1895, *Leiberg 1658* (CAL, F, G, M, NY, PO, US).

UTAH: Salt Lake City, Salt Lake Co., Oct. 12, 1907, *Garrett 2200* (GA); dry roadside, Provo Bench, Utah Co., alt. 5000 ft., Aug. 30, 1932, *Larsen 6099* (BY).

NEVADA: as a weed in waste places, Eureka, Aug. 25, 1931, *J. T. Howell 7969* (CAS).

WASHINGTON: along roadside, 6 miles west of Wenatchee, Kittitas Co., alt. 365 m., Aug. 13, 1931, *Moore & Steyermark 3693* (M); Pullman, Aug. 18, 1895, *Hardwick* (G).

OREGON: low white land, Benton Co., Aug., 1897, *Craig* (B).

CANADA: ONTARIO—dry soil, Pelham Road, St. Catherines, Aug. 14, 1898, *Carroll* (CAN).

**12a.** f. **depressa** Steyermark, f. nov.[17]

Plants low and dwarfed; stems mostly several and subcaespitose, 1–2.5 dm. tall.

Distribution: xerophytic regions in the sand hills of central Nebraska, Thomas Co., and alkaline flats around Salt Lake City, Utah.

NEBRASKA: on Middle Loup River, near Thedford, Thomas Co., Sept. 12, 1893, *Rydberg 1760* (G, NY, US).

UTAH: 16 mi. east of Salt Lake City, Salt Lake Co., alt. 1600 m., Aug. 23, 1931, *Moore & Steyermark 3766* (M); alkali flat, 5 mi. west of Salt Lake City, alt. 1300 m., Aug. 23, 1931, *Moore & Steyermark 3768* (M TYPE).

**12b.** var. **nuda** (Wood) Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, excluding plants from New Mexico and Colorado; Britt. & Brown, Ill. Fl. N. States **3**: 321. 1898, and ed. 2. **3**: 371. 1913, as synonym; Rob. & Fern. in Gray's New Man. Bot. ed. 7. 786. 1908; Rydb. Fl. Pr. & Pl. Cent. N. Am. 784. 1932, as synonym.

*G. nuda* Wood in Coulter's Bot. Gaz. **3**: 50. 1878; Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as synonym; Rydb. Fl. Pr. & Pl. Cent. N. Am. 784. 1932.

*G. squarrosa* var. *grandiflora* (Pursh) Dunal acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as to plant of *Berlandier 541 (1921)*.

Stems 1.5–6 dm. tall; leaves closely and rather evenly crenate, the main upper and middle cauline 1.5–4.5 cm. long, 0.8–1.7 cm. broad, 1½–3 times longer than broad, oval to (the lower) ovate- or broadly oblong, obtuse, subamplexicaul, glabrous; heads discoid; disk broadly hemispherical, 0.8–1.5 cm. high, 1.3–2.3 cm. broad; involucral bracts loosely squarrose.

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[17] **G. squarrosa** f. **depressa** Steyermark, f. nov., planta pusilla et humilis; caulibus paucibus vel multis, subcaespitosis, 1–2.5 dm. altis.—Collected in alkali flat, 5 miles west of Salt Lake City, Salt Lake Co., Utah, alt. 1300 m., Aug. 23, 1931, *Moore & Steyermark 3768* (Mo. Bot. Gard. Herb. no. 1027218 TYPE).

Distribution: dry open clayey or loamy ground on plains and prairies and exsiccated lake bottoms, or introduced along roadsides and railroads, from southwestern Kansas south to south-central Texas at the southern limit of the Edwards Plateau and west to the northern Texas-New Mexico boundary line; also casually introduced along railroads in west- and east-central Missouri and New Jersey.

New Jersey: Swedesboro, July 30, 1895, *Lippincott* (PB).

Missouri: railroad tracks near Allenton, 1879, *Letterman* (M); common, Courtney, Oct. 21, 1891, and 1894, *Bush 390* (G, M, NY).

Kansas: vicinity of Liberal, Sept. 22, 1912, *Rose & Fitch 17129* (NY, US); local, prairies, Emporia, Sept., 1890, *Bodin* (MU); Clark Co., Sept. 17, 1898, *White* (NY).

Oklahoma: Indian Territory, *Wilcox* (NY type); grassy roadside, Shattuck, Ellis Co., Oct. 11, 1913, *Stevens 2916* (G, M, MU, NY, US); sandy loam near Willow, Greer Co., Aug. 8, 1927, *Stratton 332* (M); Willard, Aug. 18, 1933, *Coffman* (MO); dry open ground, granite areas, Wichita National Forest, Comanche Co., *E. J. Palmer 41965* (M).

Texas: Erath Co., July 28, 1921, *Gough* (PO); 5 mi. northwest of Bluffdale, Oct. 14, 1891, *Ward* (US); Comancheriis orientales du Texas, Nov. et Dec., 1828, *Berlandier 541 (1921)* (G, NY); Bosque Co., Sept. 15, 1929, *Whitehouse* (UT); Amarillo, July 27, 1926, *Tharp 4579* (UT); roadside near Canyon City, Randall Co., Aug. 14, 1900, *Eggert* (M); dry open ground, Brownwood, Brown Co., Oct. 23, 1916, *E. J. Palmer 11111* (M); Spring Creek, south of Tankersley, Tom Green Co., Sept. 13, 1932, *Cory 4861* (CO); Ranch Experiment Station, Edwards Co., Oct. 6, 1932, *Cory 5014* (CO).

Colorado: Pueblo, 1882, *Woodward* (G, [Woodward herb.]).

New Mexico: clay soil, Nara Visa, Sept. 20, 1910, *Fisher* (MU, US).

### 12c. var. **nuda** f. **angustior** Steyermark, f. nov.[18]

Main cauline leaves 2.5–5.5 cm. long, 0.3–0.9 cm. broad, mostly 4–10 times longer than broad, chiefly linear- or narrowly oblong and acutish, rather closely and evenly crenate or crenate-serrate.

Distribution: northwestern Texas, and introduced in western Missouri.

Missouri: Jackson Co., July 15, 1892, *Bush* (M).

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[18] **G. squarrosa** var. **nuda** f. **angustior** Steyermark, f. nov., foliis caulinis principalibus 2.5–5.5 cm. longis, 0.3–0.9 cm. latis, plerumque 4–7 plo longioribus quam latis, plerumque lineari-oblongis et acutiusculis, plus minusve contigue et regulariter crenatis vel crenato-serratis.—Collected in roadside marsh 16 mi. east of Sockney on Quitaque road, Floyd Co., Texas, Aug. 23, 1921, *Ferris & Duncan 3391* (Mo. Bot. Gard. Herb. no. 902235 type, CAS, NY, isotypes).

TEXAS: staked plains, May 26–30, 1899, *Bray 448* (US); on rocky hills and by roadside, Hockley Co., Sept. 3, 1927, *Harris 110* (US); Lubbock, May 3, 1925, *Wooton* (US); roadside marsh, 16 mi. east of Sockney on Quitaque Road, Floyd Co., Aug. 23, 1921, *Ferris & Duncan 3391* (M TYPE, CAS, NY, isotypes); prairie, Amarillo, Aug. 7, 1903, *Reverchon* (M); stony hills, Bexar Co., Sept. 8, 1900, *Eggert* (M); 3 mi. north of Hale Center, staked plains, *without collector* (UT); lake bed, Nunn Ranch, Reagan Co., Sept. 19, 1932, *Cory 4928* (CO).

**12d.** var. **serrulata** (Rydberg) Steyermark in Ann. Mo. Bot. Gard. **21**: 227. 1934.

*G. serrulata* Rydb. in Bull. Torr. Bot. Club **31**: 646. 1904; in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915; Rydb. Fl. Rocky Mts. 848. 1917; Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 535. 1925, as synonym; Rydb. Fl. Pr. & Pl. Cent. N. Am. 784. 1932.

*G. squarrosa* (Pursh) Dunal acc. to Richardson, Bot. App. Franklin Narr. 749. 1823; acc. to Torr. & Gray, Fl. N. Am. **2**: 247. 1842, in major part; acc. to Wats. Bot. U. S. Geol. Expl. 40th Par. [Bot. King's Exp.] **5**: 163. 1871; acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, in large part; acc. to Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909, in part; acc. to Rydb. Fl. Rocky Mts. 848. 1917, in part; acc. to Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 535. 1925.

Herbaceous biennial; stems one to usually several, slender, more loosely corymbosely branched, frequently suffused with rose-purple to stramineous, mostly smaller than the species, 1.5–6 dm. tall; leaves (especially the middle and upper) mostly closely crenulate-serrulate with short and obtuse teeth to remotely serrulate, the main middle and upper cauline 3–6.5 cm. long, typically 0.5–1.3 cm. (rarely up to 1.7 cm.) broad, narrowly linear-oblong or oblong to oblanceolate; disk 0.6–1.0 cm. high, 0.8–1.5 cm. (rarely up to 2.0 cm.) broad; involucral bracts revolute to moderately reflexed or squarrose; rays more elongated, mostly brighter or more golden yellow than in species, the lamina usually 10–14 mm. (occasionally 8–10 mm.) long, 2–2.5 mm. broad, spatulate-oblong to oblanceolate.

Distribution: waste ground, along roadsides, low ground along streams and dry open places in Colorado, northern and central Utah, northeastern Arizona, northwestern New Mexico, and southeastern Wyoming where seemingly native; apparently introduced casually elsewhere eastward and westward in Washington, California, Nevada, Idaho, South Dakota, Nebraska, Missouri, Minnesota, Pennsylvania, Illinois, Michigan, Connecticut, Canada, etc.

UNITED STATES:

CONNECTICUT: waste ground, Nangatuck, July 19, 1908, *Blewitt* (G [Woodward herb.]).

NEW YORK: gravelly pasture slope, east of Plant Breeding Gardens, College Farm, Ithaca, Aug. 11, 1915, *Dean & Eames 5096* (G).

PENNSYLVANIA: Erie Co., *Guttenberg* (CAR).

MICHIGAN: on dry grounds, Oxford, Sept. 24, 1924, *Farwell 7195* (G).

INDIANA: near Hudson Lake, La Porte Co., Aug. 13, 1914, *Nieuwland* (D); very sandy fallow field in sec. 20, about 2½ mi. west of Flint, Steuben Co., Aug. 29, 1932, *Deam 52901* (D).

ILLINOIS: roadsides, Golconda, Aug. 20, 1902, *Gleason* (G).

MINNESOTA: in dry or moist soil, Brainerd, Aug. 8, 1903, *Mell & Knopf* (M); prairies, Rock Co., *Leiberg* (MU); river flat on U. of Minn. campus, Nov. 2, 1931, *Moyle* (MU); St. Vincent, Kittson Co., Aug., 1900, *Ballard 2554* (MU).

MISSOURI: introduced, Medill, Aug. 24, 1920, *Bush 9174* (M); Jeffrey pasture, north of stone wall, 600 High St., Columbia, Aug. 5, 1933, *Jeffrey 100* (MO); Agriculture Experiment Field, Columbia, June 28, 1928, *Rickett* (MO).

NORTH DAKOTA: moist hillsides, Faith, Aug. 8, 1912, *Moyer 193* (MU); black alluvial loam, in the vicinity of Fargo, alt. 905 ft., Aug. 20, 1901, *Waldron & Manns* (G, R, US).

SOUTH DAKOTA: Aberdeen, Aug., 1895, and Aug., 1896, *Griffiths* (F, MU); waste places, Deadwood, Aug. 5, 1913, *Rydberg 171* (F, G, M, MU, NY, R, US); prairie, Forestburg, Sanborn Co., July 15, 1918, *Visher 4411* (M).

NEBRASKA: Scott's Bluff Co., Aug. 22, and Sept., 1901, *Baker* (M); Carter Cañon, Scott's Bluff Co., July 25, 1891, *Rydberg* (NY).

MONTANA: Seven Mile Creek, 10 mi. below Glendive, Aug. 13, 1883, *Ward* (US).

WYOMING: open clay slopes near Hillsdale, Aug. 28, 1926, *Heller 14315* (M); Black Hills, on upper Cole Creek, Aug. 1, 1856, *H. Engelmann* (M).

COLORADO: common on dry plains, Denver, Sept. 1, 1910, *Eastwood 75* (M); prairie, Denver, alt. 5300 ft., Sept. 5, 1917, *Clokey 2950* (F, NY, R, US); dry soil, Buena Vista, alt. 8500 ft., Aug. 21, 1919, *Clokey 3316* (CAS, F, G, M, NY, PO, R, US, UT); Fort Collins, July 7, 1884, *Sheldon 3537* (CAL); 12 mi. west of Salida, Chaffee Co., alt. 2300 m., Aug. 30, 1931, *Moore & Steyermark 3781* (M); Fort Collins, alt. 5000 ft., Sept. 2, 1897, *Crandall* (MA, R); Fort Collins, alt. 5000 ft., Aug. 10, 1891, *Cowen* (NY TYPE of *G. serrulata*).

NEW MEXICO: along river, vicinity of Cedar Hill, San Juan Co., alt. about 1900 m., Aug. 17, 1911, *Standley 8044* (US).

ARIZONA: in sandy places, Tuba, alt. 3000 ft., July 6, 1927, *Cottam 2590* (BY).

IDAHO: Lake Coeur d'Alene, Aug. 3–4, 1926, *Epling & Houck 10032* (M).

UTAH: Wasatch Mts., alt. 6000 ft., Aug., 1869, *Watson 582* (G, NY, US); Garfield Beach on the Great Salt Lake, July 15, 1905, *Rydberg & Carlton 6916* (NY); Salt Lake City, July 23, 1879, *M. E. Jones 1062* (F, NY, PO, US).

NEVADA: Reno, July 29, 1897, *Hillman* (PO); Reno, Washoe Co., alt. 4500 ft., Aug. 10, 1912, *Heller 10639* (CAL, G, M, NY, PA, US).

WASHINGTON: small dense patches in the bottom lands near Lake Chelan, Chelan, Okanogan Co., July, 1897, *Elmer 498* (M, MU, NY, PO, US).

CALIFORNIA: Antelope Valley, Los Angeles Co., Aug. 18, 1906, *Eastwood* (CAS); Rock Creek, desert slopes of the San Gabriel Mts., Los Angeles Co., alt. 3800 ft., July 2–4, 1908, *Abrams & McGregor 626* (NY, US).

CANADA: ONTARIO—Fort Williams, along C. P. R. R., Aug. 7, 1912, *Williamson 2163* (PA); MANITOBA—Winnipeg, July 19, 1887, *Fowler* (M, MA).

*Grindelia squarrosa* has, like *G. inuloides,* been a catch-all for several distinct entities, and for a species with a relatively large distribution and which is of economic importance as a weed it has surely not received its share of critical taxonomic attention. The historical *Lewis & Clark* specimen, which is the type of the species, must be considered as typical of *G. squarrosa.* This has leaves averaging 2–4 times longer than broad, and the middle and upper cauline leaves are ovate to broadly oblong.

In passing westward and southwestward into Colorado, Utah, and northwestern New Mexico, *G. squarrosa* is replaced by the var. *serrulata,* in which the leaves still retain the regularly crenulate-serrulate margins characteristic of the species, but have become narrower and more elongated (narrowly linear-oblong to oblanceolate). Sometimes the line of demarcation between the species and var. *serrulata* is not well defined, but is distinct in those plants found in the characteristic portions of their ranges, *G. squarrosa* being mostly found in the more eastern portion and var. *serrulata* in the more western portion.

*Grindelia squarrosa* var. *nuda* occupies a more southern portion of the range, being found principally in southern Kansas, Oklahoma, and western and north-central Texas. This variety and its forma *angustior* are common in Texas, whereas typical *G. squarrosa* reaches its southern limit in northern Texas.

Numerous collections taken at or near the margins of range overlap between *G. squarrosa* and var. *serrulata* are intermediate and probably represent hybrids or are of hybrid origin. Among such collections may be mentioned that of *Goodding 533, Burglehaus* from Brainerd, Minnesota, *Sheldon* from Pipestone, Minnesota, collection of August, 1891, and many others.

**13. G. perennis** A. Nels. in Bull. Torr. Bot. Club **26**: 355. 1899; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909; Rydb. Fl. Rocky Mts. 848. 1917; Standl. in Contr. U.S. Nat. Herb. [Fl. Glac. Nat. Park] **22**: 421. 1921; Rydb. Fl. Pr. & Pl. Cent. N. Am. 784. 1932.

*G. squarrosa* (Pursh) Dunal acc. to Torr. & Gray, Fl. N. Am. **2**: 247. 1842, in part; acc. to Macoun, Cat. Can. Pl. pt. 2. 208. 1884; acc. to Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 118. 1888, in part, at least as to plant of *Bourgeau*.

*G. nana* Nutt. acc. to Millsp. Field Mus. Publ. Bot. **3**: 97. 1904.

*G. serrulata* Rydb. × *G. perennis* A. Nels., Daniels in U. Mo. Stud. [Fl. Boulder, Colo.] **2**: 227. 1911.

*G. squarrosa* var. *quasiperennis* Lunell, Am. Midl. Nat. **3**: 143. 1913.

Herbaceous biennial; stems one to usually several and subcaespitose, slender, corymbosely much branched, with ascending branchlets, usually rose-purple or sometimes stramineous, glabrous, 1–5 dm. tall; leaves typically thick and subcoriaceous, dull bluish- or grayish-green, abundantly punctate, entire to remotely serrulate (sometimes rather closely serrulate to coarsely serrate), the radical, lower, and sometimes the middle cauline often becoming irregularly coarsely incised-serrate or pinnatifid, the main middle and the upper cauline 3–6 cm. long, mostly 0.4–1 cm. broad (rarely 2 cm.), mostly 5–8 times longer than broad, at least the main cauline leaves narrowly oblong to oblanceolate, obtuse to acute, the lower mostly narrowed to the base, glabrous; heads radiate, averaging 2.2–3.3 cm. broad; disk hemispherical, 0.6–1.1 cm. high, mostly 0.7–1.6 cm. broad (sometimes up to 2 cm.); involucral bracts abundantly resinous, 4–5-seriate, the upper third to fourth strongly reflexed or revolute, 3–8 mm. long, the outer and middle bracts linear- to lanceolate-subulate with gradually attenuate apex, the free portion mostly subterete and subcoriaceous; receptacle conspicuously foveolate; rays 22–32, bright orange- to golden-yellow, lamina 7–15 mm. long; achenes oblong to narrowly oblong, 2.5–3.3 mm. long, 0.75–1.5 mm. broad, light or dark brown to stramineous, lightly striate, horizontally truncate at apex; awns 2–8, 1–5 mm. long, remotely to often moderately serrulate or setulose-serrulate, ½–⅞ length of disk-floret.

Distribution: desiccated ponds, alluvial soils along lake-shores and river-banks, short-grass high plains and northwestern prairie-plains, subsaline fields and desert flats, from southeastern British Columbia, northern Alberta, southern Saskatchewan, Northwest Territory, southern Manitoba, south to Montana, eastern Idaho, Wyoming, North Dakota, western South Dakota, and Minnesota, and introduced on Santa Catalina Island, California, and Yucatan, Central America.

UNITED STATES:

MINNESOTA: Crookston, Aug., 1900, *MacMillan & Skinner* (MU); Grand Rapids, Aug. 12, 1912, *Sandberg 286* (MU).

NORTH DAKOTA: near Minot, July 30, 1903, *Waldron 1853* (R); plains, Leeds, Sept. 8, 1908, and Butte, Aug. 2, 1909, *Lunell 1040* (MU TYPE of *G. squarrosa* var. *quasiperennis*); Dickinson, Sept. 11, 1908, *Holgate* (CAS, G, NY, US); Alkabo, Aug. 18, 1928, *Larsen 222* (M, NY); Maple Creek, Aug. 25, 1902, *Rosendahl 1140* (MU); Valley City, 1897, *Fieldstad* (R); Moon Lake, Valley City, Aug. 3, 1917, *Mabbott 204* (US).

SOUTH DAKOTA: Steppe, 12 mi. north of Crook, northwest Harding Co., July 23, 1910, *Visher 375* (F, R); Cave Hills, July, 1925, *Moore 1628* (MU); Bear Lodge Mts., Aug. 8, 1897, *Carter* (NY, R).

MONTANA: 6½ mi. southeast of Chouteau, alt. 1900 m., Aug. 16, 1931, *Moore & Steyermark 3700* (M); canyons, Helena, July, 1892, *Aiton* (MU); Bridger Pass, Gallatin Co., Aug. 20, 1916, *Suksdorf 51* (M); near Butte, alt. 5500–6000 ft., 1893, *Moore* (M); Helena, July 25, 1888, *Kelsey* (MU, N, US); low subsaline field in clay soil, 5 mi. north of Babb, Aug. 21, 1931, *J T. Howell 7882* (CAS); dry sandy soil, Teton River, alt. 3500 ft., Aug. 25, 1883, *Scribner 72* (PA); uplands, Bozeman, Sept. 4, 1905, *Blankinship 267* (F, PA, US); dry plains, Midvale, Aug. 7, 1903, *Umbach 640* (F, MA, NY, US); Sedan, July 28, 1901, *B. I. Jones* (R); 2 mi. south of Livingston, Park Co., alt. 1800 m., Aug. 16, 1931, *Moore & Steyermark 3699* (M); Park Co., 1901, *Scheuber 9* (NY); near Bonner, Aug. 31, 1892, *Sandberg, MacDougal & Heller 991* (G, NY, PO, US); near Thompson's Falls, Aug. 28, 1892, *Sandberg, MacDougal & Heller 1036* (F, G, NY, PO, US); west of Ft. Benton, *Broadhead* (M); exsiccated pond, vicinity of Glacier Park station, alt. 1440–1530 m., Aug. 16, 1919, *Standley 17760* (US); Harlowtown, July 24, 1921, *Wooton* (US).

YELLOWSTONE NATIONAL PARK: Mammoth Hot Springs, Sept. 13, 1902, *Mearns 3939* (NY, US); Gardiner City, Aug. 21, 1902, *Mearns 3489* (NY, US).

WYOMING: valley of the Big Horn River, Aug., 1859, *H. Engelmann* (M); valley of the Yellowstone River, 1860, *Hines* (M); Sweetwater River, July 27, 1898, *E. Nelson 4988* (M, N, NY, R TYPE); Meadow Creek, Aug. 9, 1894, *A. Nelson 777* (G, MU, R, COTYPES); Buffalo, alt. 4000–5000 ft., Sept., 1900, *Tweedy 3147* (NY, R); Dayton, Sheridan Co., alt. 4000 ft., Sept., 1899, *Tweedy 2077* (NY); Little Medicine River near the John Burnett Ranch, Aug., 1899, *Schuchert* (NY, US).

COLORADO: Georgetown, alt. 8300 ft., July 10, 1878, *M. E. Jones 820* (PO); Steamboat Springs, Sept., 1891, *Trelease* (M); plains, Brighton, Sept. 30, 1908, *E. L. Johnston 226a* (M).

IDAHO: Big Lost River, 1896, *Henderson 3666* (US); Big Butte Station, Snake Plains, Aug. 12, 1893, *Ed. Palmer 500* (US); near Horse Plains, Clarks Fork Valley, in region of Coeur d'Alene Mts., alt. 640 ft., Aug. 24, 1895, *Leiberg 1586* (CAL, F, G, M, NY, PO, R, US).

UTAH: 20 miles west of Orangeville, Manti National Forest, alt. 1900 m., Aug. 26, 1931, *Moore & Steyermark 3769* (M); Ogden, Aug. 6, 1887 and July 31, 1887, *Tracy & Evans 546* (MA, NY); hills and mountains north of Salt Lake City, June 9 and 12, 1905, *Rydberg 6174* (NY, R).

CALIFORNIA: sandy soil, upper Middle Ranch canyon, Santa Catalina Island, Aug. 13, 1922, *Knopf 493* (F).

CANADA:

MANITOBA: roadsides and prairies, Brandon, July 27, 1896, *Macoun* (CAN, NY); abundant everywhere on grassy prairie and roadside, Birds Hill, Aug. 1, 1915, *Thompson 8* (M).

NORTHWEST TERRITORY: Little Buffalo River, on alkali flats near end of Salt-river trail, Wood Buffalo Park, Aug. 22, 1926, *Russell* (CAN); salt plains, Bear Spring, Aug. 19, 1931, *Raup* (CAN, G).

SASKATCHEWAN: plains, Moose Jaw, Sept. 2, 1909, *Moyer* (MU); Regina, Sept. 2, 1929, *Barham* (PO); ''Sascatchawan,'' 1857–8, *Bourgeau* (G, NY); along the line of the Grand Trunk Pacific Railway, Aug. 2, 1906, *Macoun & Herriot* (CAN, G, NY).

ALBERTA: prairies and hills, Bow Valley, vicinity of Calgary, alt. 3400–3600 ft., July 19, 1913, *Moodie 27* (F, NY); dry prairie soil, Rosedale camp, vicinity of Rosedale, alt. 2200–2500 ft., Aug. 14, 1915, *Moodie 1203* (F, G, M, NY, US); Belly River, July 22, 1881, *Dawson* (CAN); Spray Valley, 9 mi. from Banff, Sept., 1927, *Sanson 1017* (NY).

BRITISH COLUMBIA: Fort Steele, Aug. 11, 1921, *Anderson* (NY); Glacier, Aug., 1895, *Schaffer* (PA).

CENTRAL AMERICA: YUCATAN—Merida, 1887, *Millspaugh 33*, introduced (F).

This is the common and widespread plant of the high plains from the Northwest Territory, Saskatchewan, Manitoba, Alberta, and eastern British Columbia south into eastern Idaho, Montana, Wyoming, North Dakota, and western South Dakota. The extreme evaporation and desiccation caused by high winds and drought, together with subsaline soils, have combined, in the main, to produce a dwarfed type of herbaceous vegetation, a fact well manifest in *G. perennis*, which has been modified from the more luxuriant *G. squarrosa*. Delimited within this high-plains region of short grass *G. perennis* is quite distinct from the more eastern and southern *G. squarrosa*. The stems are much shorter (mostly 1–4 dm. tall) than in *G. squarrosa*, the heads are smaller and especially narrower, the involucral bracts more strongly reflexed or revolute, the main cauline leaves narrower and entire or remotely serrulate, instead of regularly crenate-serrate as in *G. squarrosa,* the lower and basal leaves are often incised or pinnatifid, a condition not usually present in either *G. squarrosa* or var. *serrulata* although prevalent in *G. squarrosa* var. *nuda,* the achenes average smaller and narrower than in *G. squarrosa,* and the pappus awns are usually more strongly serrulate or setulose-serrulate. Very often, however, difficulties arise in distinguishing *G. perennis* near its southern, eastern, and western limits of dispersal from *G. squarrosa* var. *serrulata.* In several respects the latter is intermediate between *G. squarrosa* and *G. perennis,* although it manifests greater affinity with the former. In parts of South and North Dakota, southern Wyoming, Colorado, western Minnesota, eastern Idaho, and adjacent territory, hybridization between *G. perennis* and *G. squarrosa* var. *serrulata* probably occurs, especially at or near the margins of the natural ranges in the zone of range overlap. Among collections intermediate between *G. squarrosa* var. *serrulata* and *G. perennis* may be cited *Visher 603, Lunell 376, Lakela 410, Bolley* from Leeds, North Dakota, *Hayward 12, A. Nelson 9042* and *1148,* and many others.

*Grindelia perennis* might be considered a strong variety of *G. squarrosa,* but the writer believes it best at present to retain it as a separate species. It might be added that in growing many plants of *G. perennis* from seeds, the distinctive morphological and habital characters have persisted, even the dwarfed habit, which at least indicates that such characters are definitely genetically tied up with the plant and are not mere tendencies of ecological variation. Similarly, *G. squarrosa* and var. *serrulata* have upon cultivation retained their morphological characteristics of broader or narrower leaves.

14. **G. oxylepis** Greene, Pitt. **4**: 42. 1899.

*G. arizonica* Gray acc. to Gray in Proc. Am. Acad. **17**: 208. 1882, as to plant of *Palmer 467;* acc. to Wats. in Proc. Am. Acad. **18**: 101. 1883; acc. to Gray, Syn. Fl. N. Am. 1$^2$: 118. 1884, and ed. 2. 118. 1888, only as to plants from Mexico; acc. to Hemsl. Biol. Cent.-Am. Bot. **4**: 52. 1886.

*G. squarrosa* (Pursh) Dunal acc. to Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 118. 1888, as to plants from Mexico.

Stems 1 to few from a subherbaceous base, slender, glabrous, 2–5.5 dm. tall; leaves numerous, subcoriaceous or firm, dark olive-green, moderately resinous-punctate, rather remotely crenulate- or sinuate-serrulate to remotely serrate with obtusish mostly resinous-tipped teeth, lower cauline and basal irregularly and coarsely incised-dentate, the main cauline 1–3 cm. long, 3–8 mm. broad (those on floriferous branchlets gradually reduced), 2½–4½ times longer than broad, oblong, mostly obtuse or acute, subamplexicaul; heads radiate, 1.5–2.5 cm. broad; disk depressed-hemispherical, the sides distending downward in fruit, 0.7–1 cm. high, 0.8–1.6 cm. broad; involucre moderately and rather conspicuously resinous, mostly 4-seriate, the bracts 4–8 mm. long, lanceolate with acuminate to short subulate tips, glabrous, the free portion somewhat reflexed or spreading; the rays 20–30, dull yellow, the lamina 7–9 mm. long; achenes oblong, 1.5–3 mm. long, 1–1.5 mm. broad, amber to chestnut-brown, when mature finely but conspicuously and irregularly wrinkled-rugose, horizontally truncate at apex, mostly quadrangular or subquadrangular, the apex rounded with a smoothish border; awns 2–3 to the floret, capillary-linear, entire or subentire, 4–6 mm. long, equalling or nearly equalling length of disk-floret.

Distribution: moist places on plains, valleys, and old fields, State of Chihuahua, northern Mexico, south to State of San Luis Potosi, central Mexico.

MEXICO:

COAHUILA: plains near Filipinas, Oct., 1910, *Purpus 4701* (CAL, G, M, US); States of Coahuila and Nuevo Leon, Feb.–Oct., 1880, *Ed. Palmer 467* (G, PA, US).

CHIHUAHUA: plains near Chihuahua, Aug. 30, 1885, *Pringle 589* (G, US); wet places, plains near Chihuahua, Sept. 17, 1886, *Pringle 748* (CAL, G, M, MA, MU, NY, PA, R, US TYPE); Sta. Eulalia Plains, Aug. 25, 1885, *Wilkinson* (US).

DURANGO: in old cornfields at city of Durango and vicinity, June (April–Nov.), 1896, *Ed. Palmer 174* (CAL, G, M, NY, US); moist valley, Bolso de Mapimi, April 13 and 14, 1847, *Gregg 444* (M, NY).

SAN LUIS POTOSI: in the region of San Luis Potosi, 22° N. Lat., alt. 6000–8000 ft., 1878, *Parry & Palmer 371½* (G); San Luis Potosi, 1879, *Schaffner 308* (NY, US); ex convalli San Luis Potosi, in paludosis prope San Pedro, Sept., 1876, *Schaffner 308* in part (G); ex convalli San Luis Potosi, 1877, *Schaffner 308* (NY).

**14a.** f. **capitellata** Steyermark, f. nov.[19]

Heads smaller; disk small, campanulate-hemispherical to campanulate, 0.5–0.7 cm. high, 0.5–0.7 cm. broad in anthesis, becoming 1–1.3 cm. broad in fruit.

Distribution: vicinity of Mapimi, State of Durango, Mexico.

MEXICO: DURANGO—Mapimi and vicinity, Oct. 21–23, 1898, *Ed. Palmer 520* (CAL, G TYPE, M, NY, US).

**14b.** var. **eligulata** Steyermark, var. nov.[20]

Leaves rather regularly crenulate-serrulate to remotely crenulate or sinuate-serrulate, oblong, obtuse; heads discoid; bracts averaging longer, linear to lanceolate with more attenuate or subulate, subterete, thickened tips 2.5–3.3 mm. long.

Distribution: vicinity of Saltillo and San Antonio, State of Coahuila, northeastern Mexico.

MEXICO: COAHUILA—Saltillo and vicinity, Sept., 1898, *Ed. Palmer 316* (CAL, G TYPE, M, NY, US); Saltillo, alt. 5300 ft., Aug. 16, 1930, *Fisher* (CAS); San Antonio, Aug. 31, 1848, *Gregg 354* (G, M); near Saltillo, July 6, 1848, *Gregg 233* (M); valley near Saltillo, June 2, 1848, *Gregg 97* (G, M).

The small quadrangular achenes become upon full maturity finely wrinkled-rugose, whereas immature achenes show only slight irregularities on the surface.

**15. G. aphanactis** Rydb. in Bull. Torr. Bot. Club **31**: 647. 1904; in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 339. 1906; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 654. 1915; Rydb. Fl. Rocky Mts. 849. 1917; Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 534. 1925, as to synonym and plant from San Juan River.

*G. squarrosa* (Pursh) Dunal acc. to Gray in Mem. Am. Acad. N. S. **41**: 77. 1849.

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[19] **G. oxylepis** f. **capitellata** Steyermark, f. nov., capitulis parvioribus quam specie; disco 0.5–0.7 cm. alto, 0.5–0.7 cm. lato, in fructu 1–1.3 cm. lato.—Collected at Mapimi, State of Durango, Mexico, Oct. 21–23, 1898, *Ed. Palmer 520* (Gray Herb. TYPE, CAL, M, NY, US, isotypes).

[20] **G. oxylepis** var. **eligulata** Steyermark, var. nov., foliis plus minusve regulariter vel remote crenulato-serrulatis vel sinuato-serrulatis, oblongis, obtusis; capitulis discoideis; bracteis involucri patentibus vel paullum reflexis, linearibus vel lanceolatis, apicibus liberis et attenuatioribus quam specie vel subulatis, 2.5–3.3 mm. longis, subteretibus, crassescentibus.—Collected at Saltillo, State of Coahuila, Mexico, Sept., 1898, *Ed. Palmer 316* (Gray, Herb. TYPE, CAL, M, NY, US, isotypes).

*G. squarrosa* (Pursh) Dunal var. *nuda* (Wood) Gray, Syn. Fl. N. Am. 1$^2$: 118. 1884, and ed. 2. 118. 1888, only as to plants of *Fendler 390* and *Vasey*.

*G. fastigiata* Greene acc. to Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909, in large part; acc. to Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 534. 1925, as to plant from San Juan River.

*G. pinnatifida* Woot. & Standl. in Contr. U. S. Nat. Herb. **16**: 178. 1913; in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 654. 1915.

Herbaceous biennial; stems one to several, mostly slender, corymbosely much-branched with ascending, often elongated branchlets, stramineous to reddish-purple, glabrous, 1.5–9 dm. tall, uniformly leafy throughout; leaves firmly membranaceous to submembranaceous, slightly to moderately resinous-punctate, extremely variable in serration, the upper and middle cauline entire, crenulate-serrate or denticulate to coarsely crenate-serrate, the lower and basal crenate to frequently pinnatifid, the main cauline 2.5–7 cm. long, 0.25–1.2 cm. broad, mostly oblong or oblanceolate, 5–10 times longer than broad, obtuse or acute, the middle and upper subamplexicaul, glabrous except for the minutely scabridulous margin; heads discoid; disk quadrate- or campanulate-hemispherical, 0.7–2 cm. high, 1–2.8 cm. broad, broader than long; involucre moderately to slightly resinous, mostly 5–6-seriate, the upper third to half of the bracts loosely or moderately reflexed, 4–12 mm. long, linear to lanceolate with subulate tips, glabrous; achenes mostly quadrate-oblong, 2.3–3 mm. long, 1.5–2.2 mm. broad, mostly fulvous- to chestnut-brown, often quadrangular in maturity, deeply furrowed or ribbed, the ridges sometimes rugulose, mostly horizontally truncate at apex, or sometimes constricted into a shallow crown; awns 2–3 to the floret, slender, subentire to moderately setulose-serrulate, 3–5.5 mm. long, ¾–⅞ length of disk-floret.

Distribution: moist or dry meadows, fields, roadsides, rocky or sandy bars or beds along streams in valleys or canyons in the mountains, mostly in and west of the Cordilleran Range from extreme southeastern Utah and southern Colorado, New Mexico, extreme western Texas and central and eastern Arizona.

TEXAS: along road to Toyahvale, 20 miles from Ft. Davis, Jeff Davis Co., Davis Mts., alt. 1240 m., June 10, 1931, *Moore & Steyermark 3010* (M); *Havard* (US).

COLORADO: southwest Colorado, 1875, *T. S. Brandegee* (CAL); Cortez, Montezuma Co., alt. 1830 m., Aug. 27, 1931, *Moore & Steyermark 3775* (M); *Artemisia* belt, Coaldale, Fremont Co., alt. 1860 m., Aug. 30, 1931, *Moore & Steyermark 3782* (M); on dry gravelly soil, Durango, July 21, 1898, *C. F. Baker, F. S. Earle, & S. M. Tracy 526* (F, G, M, MU, NY, PO, R, TYPE collection).

NEW MEXICO: Albuquerque, Sept. 4, 1884, *M. E. Jones 4140* (CAL, CAS, F, MA, NY, PO, R, US); moist field, near Sitting Bull Falls, Guadalupe Mts., Aug. 12–20, 1924, *Standley 40708* (US); Española, Santa Fe to Las Vegas, Sept. 7, 1881, *G. Engelmann* (M); Taos, Sept. 7, 1929, *Whitehouse 7358* (B); Sandia Mts., June–Aug., 1914, *Ellis 85* (M, NY, US); Santa Fe Creek, 1847, *Fendler 390* (CAL, G, M, PA, US); vicinity of Las Vegas, San Miguel Co., Sept., 1919, *Bro. Anect 12* (CAS, G); Socorro, July, 1881, *Vasey* (G, US); Santa Fe, alt. 7200 ft., July 8, 1897, *A. A. & E. G. Heller 3828* (M, MA, MU, NY, US); dry hillside, vicinity of Ensenada, Rio Arriba Co., Aug. 24, 1914, *Standley & Bollman 10746* (US).

ARIZONA: Chiricahua Mts., Aug. 1, 1881, *Lemmon* (CAL); Adamana, Sept. 2, 1909, *Rusby* (NY); northeastern Arizona (Moki Reservation) and Little Colorado River, Aug. 1–Sept. 5, 1896, *Hough 106* (US); roadside near Prescott, Yavapai Co., alt. 1710 m., Aug. 2, 1931, *Moore & Steyermark 3682* (M); Holbrook, June 28, 1896, *Zuck* (US).

UTAH: along San Juan River, near Bluffs, alt. 1200–1500 m., Aug. 25–29, 1911, *Rydberg & Garrett 9999* (CAL, NY, R, US).

This species is quite variable in its leaf margins; these may range from entire to pinnatifid, the latter condition frequently occurring in the lower leaves. Upon this pinnatifid character, Wooton and Standley attempted to differentiate *G. pinnatifida.* However, this name must fall into synonymy, not only because much of the type collection (*Baker, Earle, and Tracy 526*) exhibits basal leaves which are pinnatifid or incised, but also because a study of a large series of specimens reveals the fact that the leaf outline is extremely variable, even on the same plant, and tendencies towards deep leaf incision are not to be relied upon for specific or varietal differentiation.

The involucral bracts are more strongly reflexed than in *G. squarrosa* var. *nuda,* but not at all strongly revolute and thickened as in *G. fastigiata* or *G. inornata.* From narrow-leaved forms of *G. squarrosa* var. *nuda,* such as f. *angustior, G. aphanactis* may be distinguished by its more markedly serrulate or setulose-serrulate pappus awns, more strongly reflexed involucral bracts, more deeply ribbed or furrowed achenes, and less regularly crenulate-serrate leaf margins.

Some tall-branching specimens of this species, as, for example, *Rydberg and Garrett 9999* from San Juan River, Utah, have been mistaken for *G. fastigiata,* but that species has more deeply campanulate exceedingly resinous heads with strongly revolute bracts.

Wooton and Standley's collections in the Organ Mts., New Mexico, obtained Sept. 20, 1908, and Sept. 23, 1906, are intermediate between *G. aphanactis* and *G. squarrosa* var. *nuda* or f. *angustior.* Hybridization may occur between these last entities where the margins of ranges overlap along the western Texas-New Mexico boundary.

**16. G. fastigiata** Greene, Pitt. **3**: 102, 1896; Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 339. 1906; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909, as to name only; Rydb. Fl. Rocky Mts. 848. 1917; Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 534. 1925, as to name, not as to plant from San Juan River.

Herbaceous perennial; stems strict, several, stoutish, fastigiately branched above with closely ascending elongated branchlets, stramineous, glabrous, 0.5–1.5 m. tall; leaves thick and subcoriaceous, light green, moderately to conspicuously punctate, entire or remotely denticulate or dentate to closely serrate, the main cauline 1.5–13 cm. long, mostly 1–1.8 cm. broad, 3–8 times longer than broad, oblanceolate to oblong-spatulate, or (the upper) chiefly oblong, obtuse to acute, glabrous; heads discoid; disk mostly deeply campanulate, as long as or longer than broad (campanulate-hemispherical before anthesis), 1.0–1.4 cm. high, 0.9–1.7 cm. broad; involucre about 6-seriate, bracts 3–9 mm. long, lanceolate to linear-lanceolate with short subulate tips, glabrous, terete, only the upper third to fourth free with closely and strongly revolute, thickened, subcoriaceous tips; receptacle conspicuously foveolate; stigmas linear-lanceolate; achenes oblong, 3.5–5 mm. long, 1.3–1.7 mm. broad, dark fulvous or chestnut-brown, slightly nerved, rather irregularly bordered with faint projections; awns 2–3, slender, remotely to moderately serrulate, 3–5.5 mm. long, ⅔–¾ length of floret.

Distribution: dry places in open desert, arid, dry, open sandbars along rivers, southeastern Utah and adjacent western Colorado.

Colorado: Grand Junction, alt. 1375 m., Sept. 15, 1901, *Underwood & Selby 504* (NY); Grand Junction, Aug., 1901, *Hedgcock* (M); De Beque, Mesa Co., Aug. 22, 1918, *Osterhout 5839* (R); Grand Junction, Aug. 27, 1896, *Greene* (N type).

Utah: in sand along Colorado River near Moab, Grand Co., alt. 920 m., Aug. 27, 1931, *Moore & Steyermark 3771* (M); on desert near roadside, 5 miles east of Woodside, Emery Co., alt. 1220 m., Aug. 26, 1931, *Moore & Steyermark 3770* (M); Lower Crossing, alt. 4500 ft., July 2, 1898, *M. E. Jones* (PO); Moab, Aug. 30, 1891, *M. E. Jones* (PO); Green River, Nov. 3, 1915, *M. E. Jones* (CAS, PO).

This little-known species is one of several which are limited to the Grand Junction region of southwestern Colorado and the region immediately westward in eastern Utah, an area apparently of great endemism for many species of flowering plants. The plants of *G. fastigiata* attain a height of 1.5 meters, and the elongate subfastigiate floriferous branchlets, deeply campanulate disk covered with conspicuously graduated strongly resinous bracts with coriaceous revolute tips, and subcoriaceous resinous leaves, combine to stamp this as a very distinct discoid species.

**17. G. inornata** Greene, Pitt. **3**: 102. 1896; Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909, as synonym of *G. fastigiata;* Rydb. Fl. Rocky Mts. 848. 1917.

Herbaceous perennial; stems several, stoutish, subcorymbosely to paniculately branched above with ascending branchlets, stramineous, glabrous, 2.5–8 dm. tall; leaves subcoriaceous, pale olive-green, slightly punctate, finely to coarsely dentate, the teeth sharply acute to subspinulose, sometimes the upper leaves toothed only about the apex, the main cauline 2–5.5 cm. long, 1.2–2.2 cm. broad, 1½–3 times longer than broad, of same breadth throughout or somewhat broader at base, obtuse or obtusish, mucronate, ovate to broadly oblong, the lower often obovate-oblong, glabrous (minutely scabridulous on margins); heads discoid; disk campanulate-hemispherical, mostly broader than long, 0.8–1.2 cm. high, 1–2 cm. broad; involucre moderately to exceedingly resinous, mostly 5–6-seriate, the bracts 5–10 mm. long, lanceolate-subulate, glabrous, the upper third to fourth strongly reflexed, subterete and thickened; achenes oblong, mostly 3–5 mm. long, about 1.5 mm. broad, stramineous to pale brown, lightly striated or smooth, apex horizontally truncate, sometimes constricted below into a conspicuous brim; awns 2–3 to the floret, slender, remotely serrulate to setulose-serrulate, 3.5–4.5 mm. long, ⅔–¾ length of disk-floret.

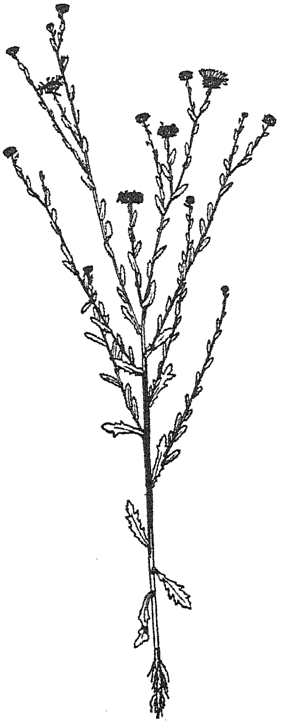

Fig. 13. *G. oxylepis.* × ⅙.

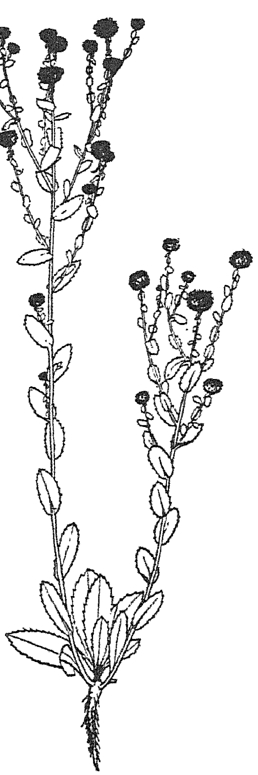

Fig. 14. *G. inornata.* × ⅙.

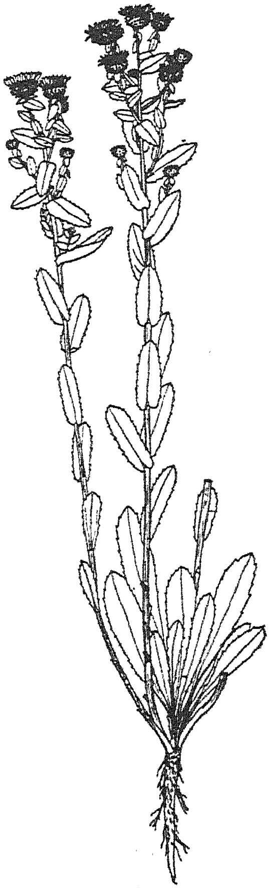

Fig. 15. *G. revoluta.* × ⅙.

**Distribution:** dry hillsides and slopes, southeastern Colorado east of the Continental Divide around Cañon City, Florence, and Pike's Peak region.

COLORADO: dry soil, 5 mi. east of Florence, Fremont Co., alt. 1575 m., Sept. 2, 1921, *Clokey 4323* (CAS, F, M, MU, NY, PA, PO, R, US); Cañon City, Fremont Co., 1871 and 1872, *T. S. Brandegee 326* (CAL, M); dry hills, Cañon City, alt. 1620 m., Sept. 2, 1921, *Clokey 4325* (CAS, F, M, NY, PA, PO, R, US); Cañon City, Sept., 1896, *Greene* (N TYPE); by road up Pike's Peak, Aug. 19, 1933, *Naylor* (MO).

17a. var. **angusta** Steyermark, var. nov.[21]

Main middle and upper cauline leaves 3–7 cm. long, 0.8–2 cm. broad, mostly 3⅔–6 times longer than broad, oblong, linear-oblong to oblong-oblanceolate, acute to acutish.

Distribution: east-central Colorado from vicinity of Denver south to Pueblo and west to vicinity of Cañon City, Fremont Co.

COLORADO: 12 miles west of Cañon City, Fremont Co., alt. 2140 m., Aug. 30, 1931, *Moore & Steyermark 3783* (M); clay soil, Barnum, Aug. 28, 1910, *Eastwood 63* (CAL, CAS, G, US); Barnum, Sept. 14, 1916, *Bethel* (CAS); prairie, Denver, Denver Co., alt. 1605 m., Aug. 27, 1921, *Clokey 4324* (D, M, MU, NY, PA, R, US); Colorado Springs, 1903, *Shantz 597* (US TYPE); Colorado Springs, Dec., 1903, *Shantz 595* (US); Broadmoor, Colorado Springs, Aug. 14, 1900, *E. T. & S. A. Harper* (F, M); Colorado Springs, alt. 1900 m., Sept., 22, 1915, *Eggleston 12029* (US); Colorado Springs, July 11, 1901, *Williamson* (PA); Cheyenne Cañon, Aug. 21, 1915, *Drushel* (M).

*Grindelia inornata* is closely related to the preceding, from which it may be distinguished by the shorter stems which are subcorymbosely or paniculately, but not subfastigiately, branched, by the more sharply dentate leaves having more saliently acute to subspinulose teeth, and by the campanulate-hemispherical disk which is generally broader than long, whereas in *G. fastigiata* it is mostly (when fully mature) longer than broad.

This species, which is rather uncommon, is apparently localized to the region around Cañon City and Florence, in Fremont Co., Colorado, a region of marked endemism.

18. **G. revoluta** Steyermark, sp. nov.[22]

*G. squarrosa* (Pursh) Dunal acc. to Gray, Syn. Fl. N. Am. 1²: 118. 1884, and ed. 2. 118. 1888, as to plant of *Greene 15 & 16* only.

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[21] **G. inornata** var. **angusta** Steyermark, var. nov., foliis caulinis mediis et superioribus 3–7 cm. longis, 0.8–2 cm. latis, oblongis, lineari-oblongis vel oblongo-oblanceolatis, acutis vel acuminatis.—Collected at Colorado Springs, Colorado, 1903, *H. L. Shantz 597* (U. S. Nat. Herb. no. 835610 TYPE).

[22] **G. revoluta** Steyermark, sp. nov., caulibus 5–8 dm. altis; foliis subcoriaceis, integris vel plerumque regulariter dentatis vel denticulatis cum dentibus brevibus

Herbaceous; stems stout, mostly subpaniculately or corymbosely branched above, stramineous or buff, sometimes suffused with rose-purple, glabrous, 5–8 dm. tall; leaves subcoriaceous, dark or pale olive-green, moderately resinous-punctate, entire or more often regularly dentate or denticulate with rather short broad teeth, the main middle and lower cauline 4–7.5 cm. long, 1.3–3 cm. broad, 2½–5 times longer than broad, mostly broadly oblong, obtuse to acutish, the main cauline subamplexicaul, of about equal breadth from base to apex, the upper leaves subamplexicaul to strongly clasping, glabrous except for the scabridulous margin; heads radiate, 2–3.5 cm. broad; disk campanulate-hemispherical to depressed-hemispherical, 1–1.3 cm. high, 1.3–2.5 cm. broad; involucre abundantly and conspicuously resinous, about 5-seriate, the upper fourth to third of the bracts strongly reflexed to mostly revolute, 4–10 mm. long, linear-lanceolate to lanceolate with subulate tips, the free revolute portion terete, thickened, and subcoriaceous; receptacle conspicuously foveolate with rather elongated acute projections; rays 21–37, short, the lamina 4–11 mm. long; achenes oblong, 3.5–4 mm. long, about 1.5 mm. broad, slightly striated, horizontally truncate at apex; awns 2 to the floret, slender, remotely serrulate to setulose-serrulate, 3.5–5 mm. long, about ¾–⅞ length of disk-floret.

Distribution: dry open ground, along roadsides, etc., central Colorado just east of the slopes of the Rockies from El Paso Co. south to northern Huerfano Co.

COLORADO: along roadside, 14 mi. south from Colorado Springs, El Paso Co., alt. 1830 m., Aug. 30, 1931, *Moore & Steyermark 3784* (M TYPE); Cañon City, 1874, *T. S. Brandegee* (M); bed of D. & R. G. Railway, Pueblo, Pueblo Co., July, 1874, *T. S. Brandegee* (CAL); Pueblo, Sept. 18, 1873, *Greene 15 & 16* (G); Pueblo, 1883, *Woodward* (G[Woodward Herb.]); Colorado Springs, alt. 6000 ft., Sept. 19–21, 1895, *Clarke* (NY); Williams Cañon, Manitou, Aug. 10, 1900, *E. T. & S. A. Harper*

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et latis, caulinis principalibus mediis et inferioribus 4–7.5 cm. longis, 1.3–3 cm. latis, 2½–5 plo longioribus quam latis, plerumque late oblongis et obtusis, caulinis superioribus et illis in ramusculis floriferis oblongis vel ovato-lanceolatis; disco campanulato-hemispherico, 1–1.3 cm. alto, 1.3–2.5 cm. lato; involucro abundanter et conspicue resinoso, bracteis plerumque revolutis, parte libera terete et subcoriacea; aristis 2 in disci flore, remote serrulatis vel setuloso-serrulatis.—Collected along roadside, 14 miles south from Colorado Springs, El Paso Co., Colorado, alt. 1830 m., Aug. 30, 1931, *J. A. Moore & J. A. Steyermark 3784* (Mo. Bot. Gard. Herb. no. 1027335 TYPE).

(F, M); sandy prairie 5 mi. east of Peyton, El Paso Co., alt. 1900 m., Aug. 31, 1931, *Moore & Steyermark 3785* (M); sandy creek bottom, Huerfano Valley, near Gardner, alt. 7000 ft., Sept. 10, 1900, *Vreeland 663* (NY, R).

This species may be considered as the probable radiate equivalent and ancestor of the discoid *G. inornata.* It occupies a limited area around central Colorado in the Cañon City-Colorado Springs region, an area shared with *G. inornata.* In addition to its radiate heads, *G. revoluta* may be distinguished from *G. inornata* by its broader leaves marked with broader and shallower dentation. Some specimens show but a slight development of rays, and it would be but another step towards the reduction of rays to effect abortion to a discoid condition as obtains in *G. inornata.*

19. **G. acutifolia** Steyermark, sp. nov.[23]

*G. subalpina* Greene acc. to Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915, as to specimens from New Mexico.

*G. texana* Scheele acc. to Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915, as to specimen from Raton, New Mexico.

Herbaceous; stems several, corymbosely branched above with spreading-ascending branchlets, buff or stramineous to reddish-purple, glabrous, 4–8 dm. tall; leaves firmly membranaceous, light grass or olive-green, saliently and sharply dentate or serrate with acute to setulose-acuminate teeth or sometimes (the uppermost) entire, the main middle and lower cauline 2.5–8.5 cm. long, 0.7–3 cm. broad, 4–5 times longer than broad, oblong or oblanceolate to lanceolate or ovate-lanceolate, the upper strongly subamplexicaul, mostly glabrous (except for the scabridulous margins); heads radiate, 2.5–3.5 cm.

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[23] **G. acutifolia** Steyermark, sp. nov., caulibus supra corymboso-ramosis, 4–8 dm. altis; foliis firme membranaceis, salienter dentatis vel serratis cum dentibus acutis vel setuloso-acuminatis, illis in ramusculis floriferis integris vel serratis, caulinis principalibus mediis et inferioribus 2.5–8.5 cm. longis, 0.7–3 cm. latis, 4–5 plo longioribus quam latis, oblanceolatis vel oblongis, caulinis superioribus lanceolatis vel ovato-lanceolatis, valde amplexicaulibus, plerumque glabris; bracteis involucri plerumque valde revolutis; aristis 2–3, remote serrulatis vel numerose serrulatis.—Collected on Johnson's Mesa, New Mexico, Aug. 16, 1910, *E. O. Wooton* (U. S. Nat. Herb. no. 663251 TYPE).

broad; disk campanulate-hemispherical, 1.2–1.5 cm. high, 1.4–2 cm. broad, involucre moderately resinous, 5–6-seriate, the upper fourth to half of the bracts strongly revolute, terete and thickened, 3.5–10 mm. long, linear-lanceolate to lanceolate with rather long subulate tips; receptacle conspicuously foveolate; rays 18–25, the lamina about 9–11 mm. long; achenes oblong, 4–5 mm. long, 1.5–2 mm. broad, stramineous or light brown, slightly striated on faces, horizontally truncate at apex; awns 2–3 to the floret, remotely serrulate to numerously serrulate, 3.8–5 mm. long, about ¾–⅞ length of disk-floret.

Distribution: dry open slopes and dry ground, southeastern Colorado in vicinity of Trinidad, to northeastern New Mexico in vicinity of Raton.

COLORADO: Wooten, Sept. 11, 1909, *Rusby* (NY); Trinidad, July, 1915, *Beckwith 218* (NY); foot of Raton Pass, near Morley, Las Animas Co., Aug. 29, 1921, *Ferris & Duncan 3538* (ST).

NEW MEXICO: canyons, vicinity of Raton, Colfax Co., alt. about 2100–2380 m., June 21 and 22, 1911, *Standley 6326* (US); Goat Mt., Raton, Aug., 1900, *W. A. & T. D. A. Cockerell* (US); Johnson's Mesa, Aug. 16, 1910, *Wooton* (US TYPE); Raton, Aug. 29, 1900, *Cockerell* (R); dry hillside, vicinity of Raton, Colfax Co., alt. about 2020 m., Aug. 18, 1916, *Standley 13291* (US); on the Colorado-New Mex. line, Raton Pass, Aug. 30, 1931, *Nelson 11745* (M).

This species is an endemic in the Raton Mesa region along the Colorado-New Mexico boundary. It has been mistaken for *G. subalpina* and var. *erecta* by several authors, but is chiefly distinguished from both by having 2–3, instead of 4–8, pappus awns to the floret. The awns in *G. acutifolia* have shorter teeth or setae than those in *G. subalpina,* in which the setae are very prominent because of length and number.

**20. G. subalpina** Greene, Pitt. **3**: 297. 1898; Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 489. 1909, excluding plants from Montana; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915, as to name only; Rydb. Fl. Rocky Mts. 848. 1917, excluding plants from Montana, New Mexico, Utah, and British Columbia; Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 535. 1925, as to name only.

*G. platylepis* Greene, Pitt. **3**: 297. 1898; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 489. 1909, as synonym; Rydb. Fl. Rocky Mts. 847. 1917.

*G. eldorae* Daniels in U. Mo. Stud. [Fl. Boulder, Colo.] **2**: 227. 1911; Rydb. Fl. Rocky Mts. 848. 1917, as probable synonym.

Herbaceous biennial to perennial; stems several, subcaespitose, slender, much corymbosely branched with strongly ascending many-flowered branchlets, stramineous to suffused with reddish-purple, glabrous 1.5–3.5 (rarely 4) dm. tall; leaves submembranaceous, light green, mostly serrulate to dentate, the basal cauline often coarsely or incised serrate or dentate, the upper and middle cauline sometimes entire or serrate only near apex, the main cauline 1.5–6 cm. long, 0.3–1.5 cm. broad, 3–7 times longer than broad, mostly oblanceolate-oblong to lanceolate-oblong and sometimes narrowed to the sessile base, acute to obtuse, glabrous except for the minutely scabridulous margin; heads radiate, numerous, mostly 2.2–3.8 cm. broad; disk quadrate-hemispherical, 0.8–1.1 cm. high, 1–2 cm. broad; involucre moderately to slightly resinous, 5–6-seriate, the up-

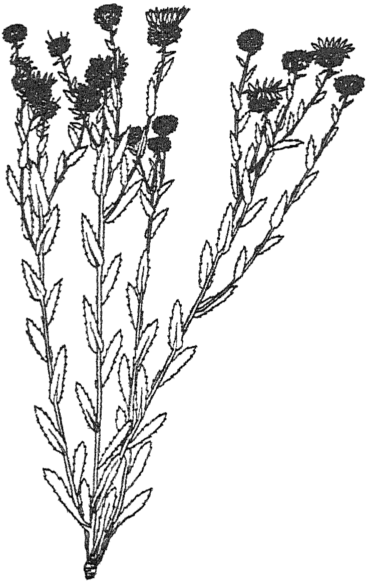

Fig. 16. *G. acutifolia.* × ⅕.

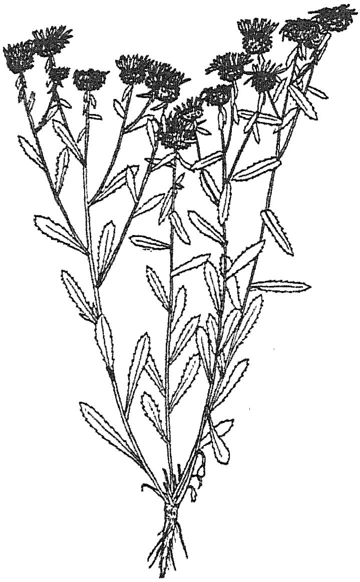

Fig. 17. *G. subalpina.* × ⅕.

per third to fourth of the bracts free and moderately reflexed, 4–10 mm. long, linear- or oblong-lanceolate to (the inner) lanceolate with acuminate or gradually tapering subulate tips, glabrous; receptacle conspicuously foveolate; rays 18–27, oblong-spatulate or elliptic-oblong, obtuse, the lamina 11–14 mm. long; achenes oblong, 2.5–3.5 mm. long, 1–1.5 mm. broad, light brown to stramineous, smooth or slightly striated especially on the angles, horizontally truncate at apex; awns 4–8, slender, acute, tapering gradually at the apex, mostly numerously setulose, 3.5–5.5 mm. long, ⅔–¾ the length of the disk-floret.

Distribution: dry, open sandy or gravelly slopes, ridges, open valley, and creek bottoms, or waste ground, about the eastern slope of the central Rockies in southeastern Wyoming and adjacent east-north-central Colorado.

WYOMING: Laramie, July 9, 1896, *Greene* (N TYPE of *G. subalpina*); sandbars, Laramie, July 27, 1913, *Macbride 2562* (M); river bottoms, Encampment, Carbon Co., alt. 7200 ft., July 10, 1901, *Tweedy 4016* (NY, US); Wyoming University Campus, July 29, 1891, *Buffum 398* (R part of TYPE collection of *G. platylepis*); dry ground, 15 mi. southwest of Laramie, Aug. 22, 1901, *Merrill & Wilcox 1168* (G, NY, R, US); sandy bottom-lands, Dunn's Ranch, Albany Co., July 18, 1900, *A. Nelson 7615* (G, M, MU, NY, PO, R, US); Sherman, July 29, 1893, *Greene* (N TYPE collection of *G. platylepis*); Sand Creek, Albany Co., July 29, 1929, *J. M. & M. T. Greenman 6032* (M); Laramie, July, *Buffum* (N TYPE collection of *G. platylepis*); stony ridges, Laramie, Albany Co., Aug. 20, 1900, *A. Nelson 8080* (G, M, MU, NY, PO, R, US).

COLORADO: Fort Collins, alt. 5500 ft., July 7, 1884, *Sheldon 6* (US); Allenspark, July 16, *Johnston & Hedgcock 314* (R); top of Lookout Mt., Golden, Aug. 28, 1916, *Johnston 226a* (NY, US); near Boulder, alt. about 1700 m., July 18, 1905, *Ramaley 1284* (R); Nederlands, Aug., 1925, *Graves 2237* (M); from the headwaters of Clear Creek and the alpine ridges lying east of "Middle Park," 1861, *Parry 48* (F, G, M, PA).

**20a.** var. **erecta** (A. Nels.) Steyermark, comb. nov.

*G. erecta* A. Nels. in Bull. Torr. Bot. Club **26**: 356. 1899; Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906, excluding plant from Cerro Summit; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 489. 1909; Daniels in U. Mo. Stud. (Fl. Boulder, Colo.) **2**: 227. 1911; Rydb. Fl. Rocky Mts. 848. 1917.

*G. squarrosa* (Pursh) Dunal acc. to Porter & Coult. Syn. Fl. Colo. 67. 1874, as to plant of *Hall & Harbour 286*.

*G. serrulata* Rydb. acc. to Daniels in U. Mo. Stud. [Fl. Boulder, Colo.] **2**: 227. 1911.

*G. subalpina* Greene acc. to Daniels in U. Mo. Stud. [Fl. Boulder, Colo.] 2: 227. 1911, as to plant of *Daniels 845.*

*G. texana* Scheele acc. to Rydb. Fl. Rocky Mts. 848. 1917, as to plant of *Osterhout 2410* from Lower Boulder Canyon; acc. to Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906.

Stem usually one from an herbaceous base, rather stout, corymbosely much-branched with strongly ascending many-flowered branchlets, 3.5–6.5 dm. tall; the lower and middle cauline leaves tending towards coarser and more incised dentation, the upper 1.5–6 cm. long, the others 6–15 cm. long, 1–3.5 cm. broad, mostly 1½–5 times longer than broad, the upper cauline oblong, oblanceolate- or elliptic-oblong to ovoid, the lower and middle broadly oblanceolate to spatulate- or obovoid-oblong, obtuse to acute, the basal tapering to a petiolate base, the upper and especially those on the floriferous branches subamplexicaul; heads mostly 3.5–4.5 cm. broad; disk 0.9–1.5 cm. high, 1–2.5 cm. broad.

Distribution: open plains and slopes about the eastern foothills of the central Rockies in southeastern Wyoming and adjacent east-north-central Colorado.

WYOMING: Blackwater, Platte, 1856, *Engelmann* (G); Laramie, July, *Buffum* (MU); Dale Creek, near Sherman, July 29, 1884, *Letterman* (M); Laramie Hills, Sept. 11, 1898, *A. Nelson 5395* (G); sandy draws, Hallock Cañon, July 4, 1900, *A. Nelson 7435* (R).

COLORADO: plains about Boulder, alt. 5600 ft., July 11, 1906, *Daniels 385* (MO); road to Boulder, Ward, Aug. 29, 1917, *Johnston & Hedgcock 215* (R); subalpine valley, Eldora, alt. 8600 ft., Aug. 31, 1906, *Daniels 845* (MO); dry soil, Eldora, Boulder Co., alt. 2575 m., Sept. 13, 1921, *Bethel, Willey & Clokey 4321* (CAS, F, M, MU, NY, PA, PO, R, US); open granite hillsides, Cherokee Park, July 29, 1923, *A. Nelson 10003* (CAL, M); open slopes, Bald Mt., near Ward, alt. about 9500 ft., Aug. 7, 1921, *Hanson C 127* (M); Lower Boulder Cañon, Boulder Co., Aug. 29, 1901, *Osterhout 2410* (NY); Georgetown, Aug. 19, 1895, *Shear 4705* (NY).

Greene was quite indiscriminate in giving the name "subalpina" to this species, since, like every other *Grindelia* of the United States and Canada, it does not inhabit the truly subalpine zone as that zone is generally understood.

A. Nelson's *G. erecta* may be considered no more than a variety of *G. subalpina* with which it intergrades. The two entities occupy a similar range; *G. subalpina* var. *erecta* represents only a more robust phase with stouter taller solitary stems, larger leaves, of which the upper are more clasping at the base, and usually with larger heads.

**21. G. decumbens** Greene, Pitt. 3: 102. 1896, not of most American authors; Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906, as to plant from Cimarron only; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915, only as to plant from type locality, Cimarron.

*G. erecta* A. Nels. acc. to Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906, as to plant from Cerro Summit only.

Herbaceous perennial; stems several or many, slender, loosely corymbosely branched near the middle with slender elongated ascending branchlets, glabrous, 1.5–3.8 dm. (sometimes up to 8 dm.) tall; leaves firmly membranaceous, entire to dentate, main cauline 2–8 cm. long, mostly 0.6–1.5 cm. broad, 3–7 times longer than broad, broadly or narrowly oblong to spatulate, acute to obtuse, the middle and especially the upper subamplexicaul, glabrous; heads radiate, 1.8–2.8 cm. broad; disk campanulate-hemispherical, 0.8–1.1 cm. high, 0.6–1.5 cm. broad; involucre moderately resinous, usually 5-seriate, the free portion reflexed, bracts 3–7 mm. long, linear-lanceolate or lanceolate-subulate to oblong-lanceolate with subterete slender tips, glabrous; rays 12–19, the lamina 7–10 mm. long; achenes oblong, 3–3.5 mm. long, 1–1.2 mm. broad, light brown to stramineous, striated, obliquely truncate to minutely bordered at the apex; awns mostly 2 to the central disk-florets, and 3–4 to the outer disk- and ray-florets, remotely to usually moderately serrulate or setulose-serrulate, 3.5–5 mm. long, ⅔ to almost equalling length of disk-floret.

Distribution: dry open hillsides and canyon slopes, southwestern to west-central Colorado in region of Gunnison Watershed.

Colorado: dry canyon sides, Norwood Hill, San Miguel Co., alt. 7000 ft., Aug. 12, 1912, *Walker 463* (G, MU, R); Cerro Summit, region of the Gunnison Watershed, alt. 8000 ft., Aug. 1, 1901, *Baker 702* (CAL, G, MU, NY, PO, R, US); 10 miles east of Montrose, Montrose Co., alt. 1220 m., Aug. 29, 1931, *Moore & Steyermark 3780* (M); 13 mi. north of Ouray, Ouray Co., alt. 1900 m., Aug. 29, 1931, *Moore & Steyermark 3778* (M); Cimarron, Aug. 30, 1896, *Greene* (N type).

**21a. var. subincisa** (Greene) Steyermark, comb. nov.

*G. subincisa* Greene, Pitt. **4**: 154. 1900; Rydb. in Colo. Agr.

Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906; Coult. & Nels. in New Man. Bot. Cent. Rocky Mts. 490. 1909; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915; Rydb. Fl. Rocky Mts. 848. 1917, excluding Arizona specimens; Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 535. 1925.

Leaves rather thin, submembranaceous, denticulate to dentate, the uppermost sometimes entire, the lower and basal cauline often becoming coarsely or incised dentate to pinnatifid, elongated, the main cauline 2–6 cm. long, 3–7.5 mm. broad, 6–15 times longer than broad, linear- or lanceolate-oblong to oblanceolate, acute; disk hemispherical to mostly depressed hemispherical; the outer involucral bracts more loosely spreading; rays 17–24, the lamina 8.5–12 mm. long; awns remotely serrulate or occasionally moderately serrulate.

Distribution: gravelly banks, low ground, and along stream courses, southwestern Colorado and adjacent north-central New Mexico.

Colorado: gravelly banks in town, Durango, July 19, 1898, *Baker, Earle & Tracy 497* in part (M, NY); Osier, alt. 2920 m., July 13, 1910, *Eggleston 5946* (US); Durango, July 26, 1898, *Baker, Earle & Tracy 600* (F, G, M, MU, NY, PO, US).

New Mexico: Chama, Sept. 5, 1899, *Baker 683* (CAL, F, G, M, NY, PO, R); vicinity of Antonito, July 7, 1911, *Standley 6506* (US); Chama, July 18, 1898, *Earle 36* (NY); along the river, vicinity of Chama, Rio Arriba Co., alt. 2380–2850 m., July 8, 1911, *Standley 6519* (US); Santa Fe, July 29, 1916, *Bro. Bertrand 80* (US).

This species has been thoroughly confused with *G. arizonica*. Most authors have treated *G. arizonica* and varieties as *G. decumbens*. However, a study of the type plant and subsequent collections discloses the fact that *G. decumbens* is the plant of southwestern and west-central Colorado with revolute or recurved involucral bracts, whereas *G. arizonica* and varieties have bracts with short, erect or appressed tips.

**22. G. laciniata** Rydb. Fl. Rocky Mts. 848 and 1066. 1917; Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 535. 1925.

*G. subincisa* Greene acc. to Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25**: 535. 1925, in part, as to specimens from Arizona.

Herbaceous perennial; stems several, slender, branched above with slender closely ascending branchlets, glabrous, 2.5–4.5 dm. tall; leaves submembranaceous to firmly membranaceous, dull green, scarcely resinous-punctate, the lower and middle cauline pinnatifid, 2–6 cm. long, 0.3–1.5 cm. broad, with coarse spreading segments 2–7 mm. long, 1–2 mm. broad, linear-oblong to oblanceolate, acute, narrowed at base, glabrous; heads radiate, 1.5–2 cm. broad; disk hemispherical, 7–10 mm. high, 7–10 mm. broad; involucral bracts 2.5–6 mm. long, lanceolate to lanceolate-oblong, acute to acuminate, closely erect-appressed, only the upper ⅓–½ of the outer bracts free and spreading, with very short tips 1–2 mm. long, glabrous or minutely ciliolate on margins; rays 12–15, the lamina 7–10 mm. long; achenes oblong, 2.5–3.5 mm. long, 1–1.2 mm. broad, dark brown, with 2 teeth or projections on the angles, or truncate; awns 3–5, slender, remotely serrulate, 3–4 mm. long, mostly ¾–⅞ length of disk-corolla.

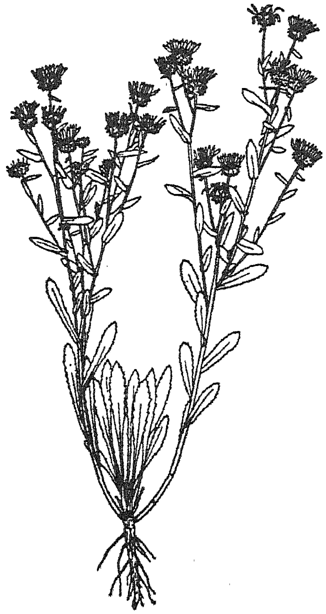

Fig. 18. *G. decumbens.* × ⅕

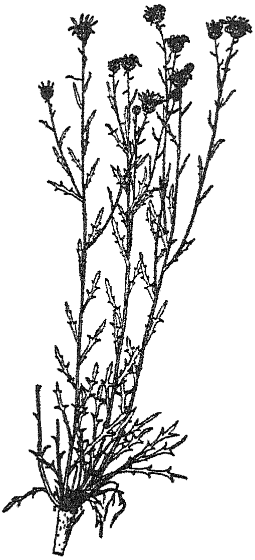

Fig. 19. *G. laciniata.* × ⅕.

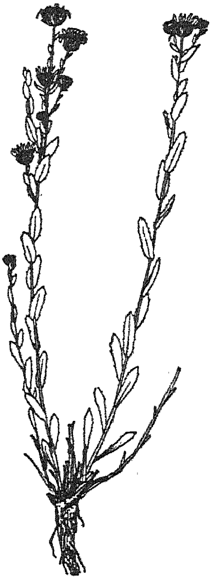

Fig. 20. *G. arizonica.* × ⅕

Distribution: dry mesas and canyons of southeastern Utah and south to vicinity of Williams and Seligman, north-central Arizona.

ARIZONA: Seligman, June 22, 1916, *Eastwood 5934* (CAS); Seligman, Aug. 10, 1911, *Wooton* (US); near Williams, Aug. 18, 1915, *Rusby* (NY).

UTAH: mesa east of Monticello, alt. 2100 m., July 25, 1911, *Rydberg & Garrett 9210* (NY); meadow south of Monticello, alt. 2100 m., July 24, 1911, *Rydberg & Garrett 9149* (CAL, NY, R); Montezuma Canyon, east of Monticello, alt. 2000 m., Aug. 13, 1911, *Rydberg & Garrett 9692* (G, MU, isotypes, NY TYPE).

**23. G. arizonica** Gray in Proc. Am. Acad. **17**: 208. 1882; Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as to synonym and plants of *Rothrock* and *Brandegee,* not plants of *Palmer* and *Wright.*

*G. microcephala* Rothr. in Rept. Wheeler Exp. **6**: 141. 1878, not *G. microcephala* DC.

*G. setulifera* Woot. & Standl. in Contr. U. S. Nat. Herb. **16**: 179. 1913; in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915.

Stems erect, usually several from an herbaceous base, irregularly or subcorymbosely branched above with ascending slender branchlets, 2.5–4.5 dm. tall; leaves membranaceous, scarcely resinous-punctate, finely and remotely setulose-denticulate with short fine teeth from base to apex, 1.5–4.5 cm. long, 0.1–1 cm. broad, 3–6 times longer than broad, the main middle and upper cauline oblong to oblanceolate, acutish, mucronate, about as broad at the base as at the middle, the lower cauline gradually narrowed at base, glabrous except for minutely scabridulous margins; heads radiate, about 2 cm. broad; disk campanulate-hemispherical to deeply campanulate, the sides not distending downwards in fruit, 0.8–1 cm. high, 0.8–1.7 cm. broad; involucre scarcely to moderately resinous, 4–5-seriate, the bracts 4–9 mm. long, broadly lanceolate to oblong-lanceolate with mostly short flattened, acuminate or acute, setulose, deltoid to triangular-lanceolate tips, all erect and appressed, glabrous; rays 15–20, the lamina about 7–8 mm. long; achenes oblong, 3–3.5 mm. long, 1.5–2 mm. broad, horizontally truncate at apex; awns 2 to the floret, entire, 4–5 mm. long, ¾–⅞ length of disk-floret.

Distribution: on mesas along escarpments and rivers, east-central Arizona and adjacent southwestern New Mexico.

NEW MEXICO: high summits, Mogollon Mts., Sept., 1881, *Rusby 206* (F, G, M, MU, NY, US, TYPE collection of *G. setulifera*); Bear Mt., 5 mi. from Silver City, Grant Co., July 12, 1928, *Wolf 2606* (ST).

ARIZONA: near summit, Pleasant Valley Road, Sierra Anchas, Oct. 10, 1931, *Harrison, Kearney & Fulton 8334* (B); Pine Creek, near Pine, Aug. 26, 1891, *McDougal* (MU); Black River, alt. 5500 ft., Sept., 1874, *Rothrock 796* (F, G TYPE).

**23a.** var. **stenophylla** Steyermark, var. nov.[24]

*G. decumbens* Greene acc. to Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906, in large part; acc. to Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915, as to plants from Farmington and Dulce; acc. to Rydb. Fl. Rocky Mts. 847. 1917; acc. to Rydb. Fl. Pr. & Pl. Cent. N. Am. 784. 1932.

Stems subpaniculately, subfastigiately or corymbosely much-branched above with rather numerous slender floriferous branchlets usually bearing numerous heads; main cauline leaves mostly entire to serrate or denticulate around apex with fine to coarse teeth, 3–7 cm. long, 0.4–2 cm. broad, mostly 5–8 times longer than broad, narrowly oblanceolate to spatulate-lanceolate, acute to acutish; awns 2–3, 3.5–4.5 mm. long.

Distribution: alluvial ground along river courses, spreading into dry fields, waste places, and dry ground on mesas, southwestern Colorado and adjacent northwestern New Mexico.

COLORADO: near Bayfield, Aug. 12, 1904, *Wooton 2568* (US TYPE); Mancos, July 4, 1895, *Eastwood* (G); Pagosa Springs, Aug. 30, 1899, *Baker 682* (CAL, F, G, M, NY, PO, R, US); dry fields south of town, Durango, July 20, 1898, *Baker, Earle & Tracy 538* (F, G, M, MU, NY, PO, R, US); Tum's Ranch, Rio Mancos, Aug., 1875, *T. S. Brandegee 1134* (CAL); trail between Parrott City and Rio Mancos, Sept., 1875, *T. S. Brandegee 4373* (M).

NEW MEXICO: shale soils, Cuba, Aug. 24, 1931, *Nelson 11718* (M); dry fields, vicinity of Farmington, San Juan Co., alt. 1550–1650 m., July 17, 1911, *Standley 6899* (US); dry fields, Jicarilla Apache Reservation, near Dulce, alt. 2150–2470 m., Aug. 20, 1911, *Standley 8141* (US).

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[24] **G. arizonica** var. **stenophylla** Steyermark, var. nov., caulibus subpaniculate vel subfastigiate et valde ramosis, ramusculis floriferis multis tenuibus elongatis, capitula multa ferentibus; foliis caulinis principalibus plerumque integris vel apud apicem serratis vel remote denticulatis cum dentibus tenuibus vel grossis, 3–7 cm. longis, 0.4–2 cm. latis, plerumque 5–8 plo longioribus quam latis, anguste oblanceolatis, spathulato-lanceolatis vel oblongo-oblanceolatis, acutis vel acutiusculis, plerumque ad basem attenuatis.—Collected near Bayfield, Colorado, Aug. 12, 1904, *E. O. Wooton 2568* (U. S. Nat. Herb. no. 1487285 TYPE).

**23b.** var. **dentata** Steyermark, var. nov.[25]

*G. arizonica* Gray acc. to Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915, as to plant from Bear Mountain.

Stems 3.5–5 dm. tall, stoutish below, mostly branched near the base to below the middle with spreading-ascending branchlets bearing solitary or few heads; main lower, middle, and sometimes the upper, cauline closely and sharply serrate or dentate with rather broad spinulose- or setulose-tipped teeth, those on floriferous branchlets and towards the heads with more slender teeth, the main lower and middle cauline 3–6 cm. long, 0.8–1.3 cm. broad, 1¾–4 times longer than broad, oblong to spatulate-oblong, mostly obtuse or acutish, slightly narrower or about as broad at base as at the middle; awns 3.3–4.5 mm. long, remotely serrulate to setulose-serrulate, acute.

Distribution: on Bear Mountain, near Silver City, Grant Co., southwestern New Mexico.

NEW MEXICO: on Bear Mountain, near Silver City, Grant Co., alt. about 8000 ft., Sept. 19, 1903, *Metcalfe 744* (G, M, MU, N, NY, R, US TYPE).

**23c.** var. **microphylla** Steyermark, var. nov.[26]

Stems slender, subpaniculately much-branched from about the middle with elongated ascending floriferous branchlets; leaves subcoriaceous, firm, the middle and upper cauline and those on floriferous branchlets finely and remotely setulose-denticulate or serrulate with short fine teeth, 1–2.5 cm. long, 0.3–0.7 cm. broad, 4–5 times longer than broad, oblong to oblong-lanceolate, acute or acutish, slightly narrower or about as

[25] **G. arizonica** var. **dentata** Steyermark, var. nov., caulibus prope basem vel infra medium plerumque ramosis, capitula solitaria vel pauca ferentibus; foliis caulinis inferioribus vel mediis contigue et salienter serratis vel dentatis cum apicibus latiusculis spinulosis vel setulosis, obtusis vel acutiusculis.—Collected on Bear Mountain, near Silver City, Grant Co., New Mexico, Sept. 19, 1903, *O. B. Metcalfe 744* (U. S. Nat. Herb. no. 495706 TYPE, G, M, MU, N, NY, R, isotypes).

[26] **G. arizonica** var. **microphylla** Steyermark, var. nov., caulibus 5–5.5 dm. et plus altis, subpaniculate et valde ramosis; foliis subcoriaceis, 1–2.5 cm. longis, 0.3–0.7 cm. latis, tenuiter et remote setuloso-denticulatis vel serrulatis cum dentibus brevibus minutis; aristis 5–6.5 mm. longis, apice acuminato tenui.—Collected along San Francisco River, 10 miles north of Clifton, Arizona, Sept. 7, 1902, *A. Davidson 736 (96)* (Gray Herb TYPE, CAL, PA, R, isotypes).

broad at base as at middle; awns entire, gradually acuminate to a slender apex, 5–6.5 mm. long.

Distribution: along San Francisco River, north of Clifton, Greenlee Co., southeastern Arizona.

ARIZONA: San Francisco River, 10 miles north of Clifton, Sept. 7, 1902, *Davidson 736 (96)* (CAL, G TYPE, PA, R).

**24. G. scabra** Greene in Bull. Torr. Bot. Club **25**: 120. *pl. 332.* 1898; Woot. & Standl. Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915.

Stems 1–4 from an herbaceous base, usually slender, loosely corymbosely branched, mostly suffused with reddish-purple, villous or villosulous-puberulent, less so below, 2–7 dm. tall; leaves rather thin, submembranaceous, dull green, scarcely punctate, usually moderately denticulate or setulose-denticulate, the lower more coarsely dentate, 2–8.5 cm. long, 0.5–2.5 cm. broad, the majority ovoid-oblong to lanceolate, the lower oblong-spatulate to broadly oblanceolate, obtuse to acute, all but the lowest usually subamplexicaul, mostly minutely puberulent; heads radiate, 2.5–4 cm. broad; disk 0.7–1.1 cm. high, 1.0–1.8 cm. broad; involucre scarcely resinous; bracts 6–11 mm. long, loosely erect, ascending or spreading, the outer elongated, usually about equalling the height of the disk, linear- or lanceolate, with mostly filiform-subulate tips, scaberulent on surfaces and margins, the inner oblong-lanceolate or oblanceolate, glabrate; rays 17–30, the lamina 12–15 mm. long; achenes oblong, 2.5–3 mm. long, 1.5–2 mm. broad, light brown, smooth to slightly striate, mostly obliquely truncate at apex; awns 2–4, nearly capillary, moderately to numerously setulose, 3–5 mm. long, mostly ¾–⅞ length of disk-floret.

Distribution: dry rocky slopes or mesas in mountains of the eastern slope of the southern Rocky Mountain axis of southeast-central New Mexico and the Davis Mountains of northwestern Texas.

TEXAS: dry rocky ground on ridge above Little Ajuga Canyon, Davis Mts., Jeff Davis Co., alt. 1500 m., June 13, 1931, *Moore & Steyermark 3043*, and June 17, 1931, *Moore & Steyermark 3151* (M).

NEW MEXICO: White Mts., Lincoln Co., alt. 6300 ft., July 28, 1897, *Wooton 224* (CAL, G, M, MU, NY, PO, R, TYPE collection); Mescalero Indian Reservation, White Mt. Region, Lincoln Co., alt. 6500 ft., June 23, 1895, *Wooton* (US); Cold Spring Cañon, Sacramento Mts., Otero Co., Aug. 17, 1899, *Wooton* (US); Tularosa

Creek, 3 mi. south of Mescalero Agency, Otero Co., alt. 6930 ft., July 19, 1928, *Wolf 2772* (CAS); White Mts., Lincoln Co., alt. 6300 ft., Aug. 21, 1897, *Wooton 372* (CAL, G, M, MU, NY, PO, R, US, COTYPES).

**24a.** var. **neomexicana** (Woot. & Standl.) Steyermark, comb. nov.

*G. neomexicana* Woot. & Standl. in Contr. U. S. Nat. Herb. **16**: 198. 1913; in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19**: 655. 1915.

*G. arguta* f. *glabra* Gray in Smithson. Inst. Contr. [Pl. Wright. pt. 2] **5**$^6$: 81. 1853.

*G. arizonica* Gray acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, as to plant of *Wright* only.

*G. squarrosa* var. *grandiflora* (Hook.) Gray acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, in small part, as to plant from Hort. Cantab. in Gray Herb. and in part of description as to "leaves . . . with . . . spinulose teeth."

*G. arguta* Schrad. acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as synonym.

Stems smooth, glabrous; leaves glabrous except for the scabridulous margins.

Distribution: dry rocky slopes of canyons and ledges, the higher portions of the mountains of southwestern New Mexico and south in the Davis Mountains of northwestern Texas.

TEXAS: rocky ledges, Sawtooth Mountain, Davis Mts., Jeff Davis Co., Oct. 3, 1926, *E. J. Palmer 31877* (M, UT); Fern Canyon, 14 mi. northwest of Alpine, southern Jeff Davis Co., Sept. 18, 1927, *Cory 26*, and Sept. 28, 1927, *Cory 27* (B, US).

NEW MEXICO: Kingston, Sierra Co., in and around the south end of the Black Range, alt. 6600 ft., Sept. 9, 1904, *Metcalfe 1302* (M); mountains north of Santa Rita, Aug. 23, 1900, *Wooton* (US TYPE); Silver City, 1911, *Beard* (M); mountains southeast of Patterson, Aug. 16, 1900, *Wooton* (US COTYPE); on the G.O.S. Ranch in canyons within 10 miles of the ranch house, Grant Co., Aug. 27–Sept. 12, 1911, *Holzinger* (US); sandy clay loam, woodland, Tierra Blanca Canyon, Gila Forest, alt. 6800 ft., Aug. 16, 1915, *Chapline 267* (NY, US).

Wooton and Standley's *G. neomexicana* differs in no essential respects from *G. scabra* except in lack of pubescence, on which character alone specific rank cannot be accorded. Some specimens of *G. scabra* show a tendency towards glabrity of the leaves and stems. In New Mexico *G. scabra* is concentrated around the southeast-central portion in the Sacramento and

White Mountain area, whereas the var. *neomexicana* occurs in the mountains of the southwestern part of the state.

The capillary-like pappus awns, and long-filiform or subulate erect or ascending scarcely resinous involucral bracts are characters possessed by *G. scabra* and var. *neomexicana* which point to an ancestry from the more ancient Texan-Mexican alliance, especially (in the case of *G. scabra* with its pubescent stems and leaves) as having originated from some stock simulating *G. inuloides*. The replacement westward by the glabrous *G. scabra* var. *neomexicana* may be considered a derived condition induced by ecological isolation.

**25. G. texana** Scheele in Linnaea **21:** 601. 1848; Gray in Smithson. Inst. Contr. [Pl. Wright. pt. 1] **3**$^5$: 98. 1852, as synonym; Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as synonym; Rydb. in Colo. Agr. Exp. Sta. Bull. [Fl. Colo.] 100: 338. 1906, as to name only; Coult. & Nels. New Man. Bot. Cent. Rocky Mts. 490. 1909, as to name only; Daniels in U. Mo. Stud. [Fl. Boulder, Colo.] **2:** 226. 1911, as to name only; Woot. & Standl. in Contr. U. S. Nat. Herb. [Fl. N. Mex.] **19:** 655. 1915, as to name and type locality only; Rydb. Fl. Rocky Mts. 848. 1917, as to name only.

*G. lanceolata* Nutt. acc. to Torr. & Gray, Fl. N. Am. **2:** 248. 1842; Walp. Rep. Bot. Syst. **2:** 959. 1843.

*G. squarrosa* var. *grandiflora* Gray in Smithson. Inst. Contr. [Pl. Wright. pt. 1] **3**$^5$: 98. 1852, excluding *G. grandiflora* Hook.; Walp. Ann. **5:** 191. 1858; Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, in part, as to description pertaining to "leaves . . . with spinulose teeth," as to plants of *Lindheimer* and *Reverchon*, and excluding *G. grandiflora* Hook.; Coult. in Contr. U. S. Nat. Herb. [Bot. W. Tex.] **2:** 184. 1892, in part, as to description pertaining to "leaves . . . with . . . spinulose teeth."

*G. grandiflora* of many authors, not *G. grandiflora* Hook. acc. to Small, Fl. Southeast. U. S. 1180. 1903, and ed. 2. 1180. 1913; Blake in Tidestrom in Contr. U. S. Nat. Herb. [Fl. Utah & Nev.] **25:** 535. 1925, as to name and range in Texas.

Herbaceous perennial; stems from a lignified base, sparsely

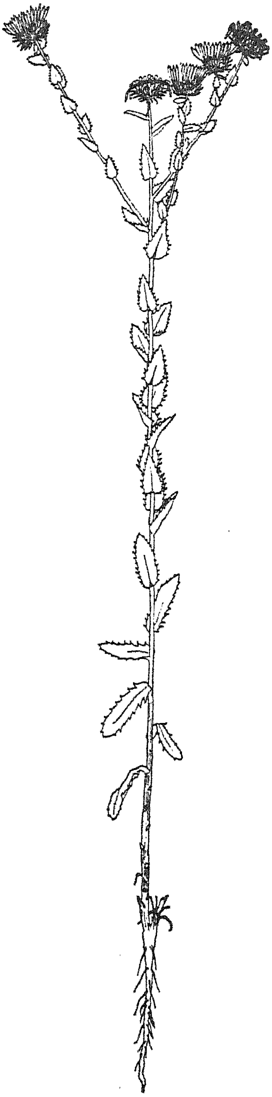

Fig. 21. *G. texana.* × ⅕.

corymbosely branched in the inflorescence above the middle, usually stramineous or light brown, shining, glabrous, 4.5–9.5 dm. tall; leaves firm, subcoriaceous, light green, scarcely punctate, the basal and lower cauline especially sharply incised-serrate to pinnatifid with teeth or segments deltoid to oblong-lanceolate, 4–15 mm. long, 1–5 mm. broad, the middle and upper cauline coarsely to spinulosely serrate with deltoid to lanceolate spinulose-tipped teeth 1–4 mm. long, acute, leaves lanceolate-oblong to lanceolate-linear, the upper ovate, 1–6.5 cm. long, 0.3–2.5 cm. broad, glabrous except for the margins; heads few, radiate, 2.5–4 cm. broad; disk 1–1.5 cm. high, 1.2–2.4 cm. thick, campanulate-hemispherical; involucre sparingly to moderately resinous, 6–8-seriate, the bracts 4–13 mm. long, lanceolate-subulate to lanceolate-oblong, the innermost erect, appressed and acuminate at apex, the others with upwardly spreading to ascending subulate tips, free about half the entire length, the outer bracts shorter than (frequently only half) the height of the disk, glabrous; rays 21–36, the lamina 12–15 mm. long; achenes oblong to obovate, 3–5 mm. long, 2–2.5 mm. broad, brownish, smooth or striated, the apex inconspicuously bordered or with 1–2 small projections at the angles; awns 2, linear-subulate, stoutish, mostly stouter than in *G. lanceolata* and form, subentire or entire, 4–7 mm. long, nearly equalling the disk-floret.

**Distribution:** on limestone glades and prairies from the Arbuckle Mountains of south-central Oklahoma south in the Texas Hills section and Edwards Plateau of south-central Texas.

Oklahoma: in the Indian Territory, chiefly on the False Washita, between Fort Cobb and Fort Arbuckle, 1868, *Ed. Palmer 452* (NY); Arbuckle Mts., near Davis, Aug. 18, 1917, *Emig 811* (M); limestone hills, Arbuckle Mountains, near Turner Falls State Park, Garvin Co., Aug., 1933, *E. J. Palmer 42014* (M).

Texas: Comanche Spring, New Braunfels, etc., July, 1849, *Lindheimer 920* (CAL, F, G, M, NY, PA, US, UT); 1846, *Lindheimer* (G, US); sparsely in dry prairies of the higher mountain valleys, Comanche Spring, July, 1847, *Lindheimer 83* (G); western Texas, 1852, *Wright* (G, NY, US); Holland, Sept. 5, 1913, *Mackensen 236* (M); Fort Worth, Sept. 9, 1877, *Ward* (M, US); dry black calcareous soil, Lisbon, Dallas Co., Sept. 10, 1913, *Pennell 5408* (NY); Spanish Pass, Kendall Co., July 5, 1911, *Mr. & Mrs. J. Clemens 949* (M, PO); dry hillsides, Blanco, Blanco Co., Sept. 24, 1917, *E. J. Palmer 12855* (G, M); prairie, Tarrant Co., 1926 or 1927, *Killian* (UT); Cleburne, July 22, 1929, *Whitehouse 6646* (B, UT); rocky hills, Polytechnic, June 30, 1911, *Ruth 64* in part (G, M, NY, PA, US); dry calcareous open ground, Burnet, Burnet Co., June 21, 1916, *E. J. Palmer 10249* (M); Austin, Aug. 1921, *Schulz 688* (PO, US); Half Moon Mt., Gillespie Co., *Jermy 805* (M, US).

This species has been previously referred to in part as *G. grandiflora* or *G. squarrosa* var. *grandiflora*. Gray[27] erroneously combined under *G. squarrosa* var. *grandiflora* three very unlike elements; the first, consisting of plants of *Lindheimer* and *Reverchon* with spinulose-toothed leaves, really pertained to *G. texana*, the second, comprising an obtuse-toothed plant of *Wright*, referred to the new entity as treated in the present monograph, namely, *G. Havardii*, while the third, including an obtuse-toothed plant, collected by *Berlandier*, can be identified with *G. squarrosa* var. *nuda*. It is difficult to understand how Gray could have confused these specimens, since *G. texana* is quite unlike *G. Havardii*, and the latter, a radiate species, is very distinct from the discoid *G. squarrosa* var. *nuda* with which Gray confounded it.

**26. G. lanceolata** Nutt. in Jour. Acad. Phila. **7**: 73. 1834; Torr. & Gray, Fl. N. Am. **2**: 248. 1842, including var. β and excluding var. γ; Walp. Rep. Bot. Syst. **2**: 959. 1843, including var. β and excluding var. γ; Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888; Britt. & Brown, Ill. Fl. N. States **3**: 321. 1898, and ed. 2. **3**: 371. 1913; Rob. & Fern. in Gray's New Man. Bot. ed. 7. 786. 1908; Small, Fl. Southeast, U. S. 1180. 1903, and ed. 2. 1180. 1913; Rydb. Fl. Pr. & Pl. Cent. N. Am. 784. 1932.

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[27] Gray, A., Syn. Fl. N. Am. 1$^2$: 118. 1884, and ed. 2. 118. 1888.

*Donia lanceolata* Hook. acc. to Eaton & Wright, N. Am. Bot. ed. 8. 227. 1840, not Hooker; acc. to Eaton, Man. Bot. N. Am. ed. 7. 281. 1836, not Hooker.

Herbaceous biennial; stems one to several from a semiligneous base, corymbosely much-branched above the middle, ochroleucous or stramineous below, the upper part suffused with reddish-purple, glabrous or infrequently sparsely pilose near the base, 0.3–1.5 m. tall; leaves firmly membranaceous, light green, scarcely punctate, entire or finely serrulate to sharply serrate, acute to acuminate, the lower and middle cauline 3.5–11 cm. long, 0.35–2 cm. broad, linear to lanceolate-oblong, the upper cauline and those on floriferous branchlets shorter, 4–12 times longer than broad, mostly glabrous, the margins scabrid, lower cauline and basal frequently short-pilose on both surfaces; receptacle conspicuously foveolate; heads radiate, 3–3.5 cm. broad; disk campanulate-hemispherical in anthesis, 0.8–1.3 cm. high, 1.2–2.3 cm. broad; involucre sparingly and inconspicuously resinous, the bracts 8–16 mm. long, linear or lanceolate, acuminate at apex, with loosely spreading to ascending filiform subulate tips, these free for ½–⅞ the length of the bract, the inner bracts erect, appressed, and usually exceeding the height of the disk, the outer about equalling the height of the disk, glabrous; rays 14–29, the lamina 10–16 mm. long; achenes oblong to linear-oblong, 4–6 mm. long, 2–2.5 mm. broad, stramineous to grayish or grayish-brown, smooth, lustrous, the apex inconspicuously crowned or with 1–2 small projections at the angles; awns 2, linear, slender, sometimes slightly dilated at apex, entire, 4–7 mm. long, about as long as the disk-floret.

Distribution: limestone glades and rocky prairies from the Ozark region of Missouri and Arkansas, and southeastern Kansas south to northeastern Texas, locally eastward in Tennessee and central and northern Alabama.

LOUISIANA: *Leavenworth* (G, NY).

TENNESSEE: cedar glades near Lavergne, Rutherford Co., Aug. 18, 1897, *Eggert* (CAL, F, M, NY, US); cedar barrens at Lavergne, June, 1879, *Gattinger* (M, NY, PA, US); dry fields, Nashville, July and Aug., 1897, *Williamson* (PA, NY); Nashville, *Gattinger* (CAL, M, US).

ALABAMA: Jonesboro, *E. A. Smith* (F, US); Colbert Co., *E. Smith* (MA).

MISSOURI: along R. R. tracks just north of Washington University grounds, opposite men's fraternities, St. Louis Co., Oct. 13, 1930, *Steyermark 1506* (M); in dense colonies on limestone glade, above St. Peter sandstone bluffs, 8 miles northwest of Pevely, Jefferson Co., Sept. 11, 1932, *Steyermark 7164* (M); dry open ground, limestone hills, near Carthage, Jasper Co., Oct. 6, 1925, *E. J. Palmer 29049* (G, M); common in woods, Carterville, Aug. 17, 1902, *E. J. Palmer 181* (M); thickets and open limestone ledges, near Eve, Vernon Co., Aug. 7, 1933, *E. J. Palmer 42157* (M); shale outcrops, hillsides, Noel, McDonald Co., Sept. 7, 1913, *E. J. Palmer 4161* (M, R); Little Osage River near the Mo. state line, Aug. 1869, *Broadhead* (M); Cedar Gap, Sept. 25, 1903, *Standley* (US); Bagnell to Linn Creek, Camden Co., Sept. 17, 1897, *Trelease 547* (M); near Ava, Sept. 2, 1929, *Rickett* (MO).

ARKANSAS: Maumee, Searcy Co., Aug. 8, 1913, *Emig 45* (M); White River bottom, south of Batesville Ferry, July 29, 1887, *Coville 197* (US); locality lacking, *Pitcher* (PA TYPE, NY); dry situations, prefers limestone, Fayetteville, *Harvey 48* (M, MU, PA, US); dry rocky bluffs, Cotter, Baxter Co., Aug. 31, 1915, *E. J. Palmer 8403* (M, NY); rocky hillsides, Jasper, Newton Co., Oct. 28, 1914, *E. J. Palmer 6936* (M); Hot Springs, Aug., and Aug. 5–6, 1879, *Letterman* (F, M); Little Rock, Aug., 1879, *Letterman* (M).

KANSAS: prairie, Allen Co., 1896, *A. S. Hitchcock 714* (G, M, NY, US); Crawford Co., Aug. 12, 1897, *Clothier & Whitford 5459* (PO); open ground, limestone outcrops, along prairie creek, near Valeda, Labette Co., July 21, 1933, *E. J. Palmer 41779* (M).

OKLAHOMA: Cherokee Nation, Aug. 19, 1895, *Blankinship* (G, M, US); Atoka, 1874, *Butler* (M); on rocky hillside, near Burbank, Osage Co., Aug. 7, 1913, *Stevens 1950* (G, M, MU, NY, US); dry grassy roadside, Miami, Ottawa Co., Aug. 27, 1913, *Stevens 2446* (G, MU); Sans Bois Mts., Aug. 21, 1891, *Sheldon 308* (US); uncommon, Sapulpa, July 27, 1894, *Bush 220* (G, M, NY, US).

TEXAS: on limestone rocky ground, Dallas Co., Aug. 31, 1926, *Ruth 1432* (US); S. Felipe de Austin, "Hooker misit," Jan., 1835, *Drummond 137* (G); prairie, Ft. Worth, 1926, *Killian 6599* (B, UT).

### 26a. f. **latifolia** Steyermark, f. nov.[28]

Leaves broadly oblong, oblong-lanceolate, or especially the upper ovate-lanceolate, acute, sharply denticulate or serrulate, at least the upper and middle cauline subamplexicaul, 2½–3 times longer than broad, the larger 5.5–7 cm. long, 2–2.8 cm. broad.

Distribution: limestone hills, southwestern Missouri and eastern Oklahoma.

MISSOURI: Marble Cave, Stone Co., Sept. 11, 1898, *Trelease* (M TYPE).

OKLAHOMA: dry limestone prairies, Hugo, Choctaw Co., Oct. 25, 1915, *E. J. Palmer 9013* (M, NY).

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[28] **G. lanceolata f. latifolia** Steyermark, f. nov., foliis late oblongis, oblongo-lanceolatis, superioribus ovato-lanceolatis, majoribus 5.5–7 cm. longis, 2–2.8 cm. latis.—Collected at Marble Cave, Stone Co., Missouri, Sept. 11, 1898, *W. Trelease* (Mo. Bot. Gard. Herb. No. 129998 TYPE).

This species is quite variable as to leaf shape, size, and margin, but the variations are not concomitant. On the limestone barrens of Tennessee and in portions of southwestern Missouri, southeastern Kansas, and Oklahoma, are plants with narrower leaves and subentire or finely setulose margins, but too many inconstancies and intergradations are encountered for these variations to be significant. In the vicinity of Dallas, Texas, a region of range overlap of *G. texana* and *G. lanceolata* (near the northeastern limit of *G. texana* and near the southwestern limit of *G. lanceolata*) collections have been taken which are intermediate between, and may be hybrids of *G. texana* and *G. lanceolata*.

27. **G. littoralis** Steyermark, sp. nov.[29]

Stems sparsely branched and elongated above in the inflorescence, brownish to stramineous, glabrous; leaves coriaceous to subcoriaceous, dark olive-green, moderately or conspicuously punctate and resinous, closely and upwardly appressed-serrulate, the middle and upper cauline 3–5.5 cm. long, 0.8–1.5 cm. broad, lanceolate- to elliptic-oblong or elliptic-lanceolate, rather abruptly narrowed to the sessile base, with a slender acuminate tip, glabrous; heads radiate, 3–3.5 cm. broad; disk campanulate-hemispherical in anthesis, 0.8–1.2 cm. high, 1.4–2 cm. broad; involucre moderately to abundantly resinous, the bracts 8–13 mm. long, linear or lanceolate to lanceolate-oblong with loosely spreading or ascending filiform-subulate tips free for ½–⅞ their length, the outer ones strongly arcuate-involute above, about equalling the height of the disk, glabrous; rays 25–31, the lamina 11–13 mm. long; achenes oblong, 3.5–4 mm. long, about 2 mm. broad, stramineous, smooth, shining, the apex bordered by an irregular slightly raised margin or with 1–2 small projections at the angles; awns 2, rather slender, mostly dilated towards apex, the margins minutely marked with several remote projections, 4.2–6 mm. long, about equalling the disk-floret.

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[29] **G. littoralis** Steyermark, sp. nov., foliis subcoriaceis, moderatim vel valde resinoso-punctatis, tenuiter serrulatis cum dentibus valde appressis et incurvis, caulinis mediis et superioribus 3–5.5 cm. longis, 0.8–1.5 cm. latis, lanceolatis vel elliptico-oblongis vel elliptico-lanceolatis, ad basem angustiusculis; involucro moderatim vel valde resinoso, bracteis lineari- vel lanceolato-subulatis, exterioribus valde arcuato-involutis.—Collected at Evergreen, Galveston Bay, Texas, Sept. 20, 1884, *Joor* (Mo. Bot. Gard. Herb. no. 130019 TYPE).

Distribution: Galveston Bay region of southeastern Texas.

TEXAS: beach, Evergreen, Galveston Bay, Sept. 20, 1884, *Joor* (M TYPE); Kemah, alt. 20 ft., Aug. 19, 1917, *Fisher 5156* (CAS, US); Kemah, alt. 20 ft., Sept. 6, 1926, *Fisher 265* (B, US); La Porte, Aug. 9, 1913, *Fisher 629* (US); Houston, Aug. 10, 1921, *Fisher 119* (US).

This endemic of the Galveston Bay region is intermediate between *G. lanceolata* and *G. texana.* It possesses a larger amount of resin both on the leaves and involucre than either of the latter species; the leaf margins have teeth which are closely appressed and incurved, whereas in *G. texana* and *G. lanceolata* the teeth are directed outward and are more salient; the pappus awns in *G. littoralis* are mostly marked with several projections, whereas in the other two species they are entire or subentire.

This species may have been derived from a Mexican type similar to *G. Greenei* to which it is related. *Grindelia littoralis* has subpaleaceous pappus awns, whereas those in *G. Greenei* are capillary-like.

**28. G. Greenei** Steyermark, sp. nov.[30]

Stems amber or fulvous-brown, glabrous, up to 1.2 m. tall; leaves subcoriaceous, dark olive-green, moderately resinous-punctate, evenly and closely serrulate with aristate or spinulose-tipped teeth from base to apex, the upper cauline 1.9–2.9 cm. long, 1–1.5 cm. broad, 1½–2⅓ times longer than broad, ovate to oblong- or elliptic-ovate, acuminate-cuspidate, slightly narrowed at the base, glabrous; inflorescence sparingly subcorymbosely branched; heads radiate, 2.5–2.7 cm. broad; disk campanulate-hemispherical, 0.8–1 cm. high, 1.3–1.7 cm. broad; involucre moderately resinous, 0.8–0.9 cm. high, the bracts 4–7.5 mm. long, the upper ⅓–½ free and spreading, the outer and middle linear to lanceolate with subulate flattened subcoriaceous tips 2–3 mm. long, glabrous; rays 15–20; achenes oblong, 2.3–3 mm. long, 1–1.5 mm. broad, fulvous-brown, shining, smooth, truncate at apex; awns 2–3 to the floret, capillary-linear, entire, acute, 4–5 mm. long, about ⅞ length of disk-floret.

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[30] **G. Greenei** Steyermark, sp. nov., caulibus glabris; foliis subcoriaceis, moderatim resinoso-punctatis, regulariter et contigue serrulatis cum dentibus aristatis vel spinulosis, caulinis superioribus 1.9–2.9 cm. longis, 1–1.5 cm. latis, 1½–2⅓plo longioribus quam latis, ovatis vel oblongo- vel elliptico-ovatis, acuminato-cuspidatis, ad basem paullum attenuatis, glabris; capitulis 2.5–2.7 cm. latis; disco campanulato-hemispherico, 0.8–1 cm. alto, 1.3–1.7 cm. lato; involucro moderatim resinoso, bracteis liberis, patentibus, 4–7.5 mm. longis, lineari- vel lanceolato-subulatis, glabris; achaeniis laevibus.—Collected in vicinity of Monterey, State of Nuevo Leon, Mexico, 1924, *C. R. Orcutt 1204* (U. S. Nat. Herb. no. 1207776 TYPE).

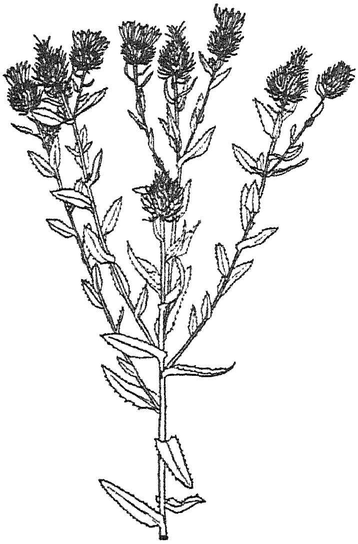

Fig. 22. *G. lanceolata.* × ⅕

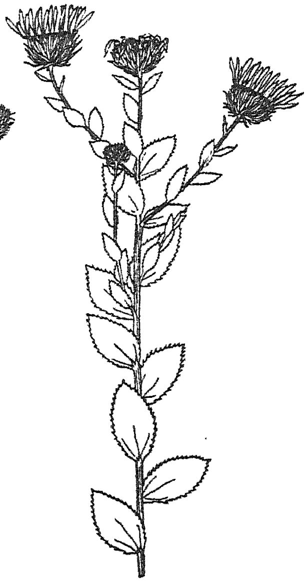

Fig. 23. *G. Greenei.* × ⅖.

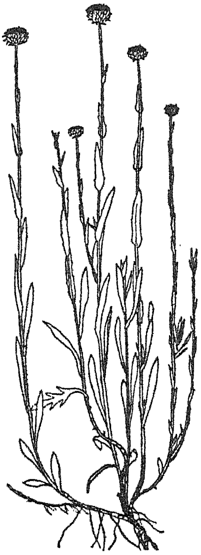

Fig. 24. *G. oolepis.* × ⅕.

Distribution: vicinity of Monterey, State of Nuevo Leon, northeastern Mexico.

MEXICO: NUEVO LEON—Monterey, 1924, *Orcutt 1204* (US TYPE); Monterey, 1924, *Orcutt 1249* (US).

It is a pleasure to name this new species in honor of Dr. E. L. Greene, who perhaps had a keener insight and more understanding of the genus than any other botanist having worked with *Grindelia.*

**29. G. oolepis** Blake in Proc. Biol. Soc. Wash. **41:** 139. 1928.

Stems several from a slightly decumbent to ascending base, slender, mostly simple and elongated, some of the older ones becoming ligneous and producing simple herbaceous shoots from the base or from the cauline nodes, obscurely puberulous with few short hairs about the apex of the penduncles, otherwise glabrous, dull green, 1.7–5.5 dm. tall; leaves firmly membranaceous, not resinous-punctate, main cauline entire or sparingly minutely toothed to remotely denticulate, the basal and lower leaves pinnatifid or incised-dentate, main cauline linear, lanceolate-oblong or lanceolate, mostly acute, sessile, the upper with a slightly broader and more clasping base than the lower, leaves 1–5.5 cm. long, 2–7 mm. broad, glabrous to obscurely puberulous; inflorescence a solitary discoid head terminating a simple slender elongated stem; disk hemispherical, 6–9 mm. high, 8–14 mm. broad; receptacle with no obvious foveolation; involucre with only the innermost bracts of young heads slightly resinous, bracts 4–5-seriate, 3–5.5 mm. long, 1–2 mm. broad, all erect and appressed, the outer ovate-lanceolate to lanceolate-oblong with loose or spreading acute flattened tips, glabrous; achenes dark or yellow-brown, dull, smooth to obscurely rugulose, oblong, about 3 mm. long, 1.5–2 mm. broad, truncate at the apex; awns 1–2 to the floret, when 2 unequal, acute, very slender, entire, 4–4.5 mm. long, ¾–⅞ the length of the corolla.

Distribution: gumbo soil near coast, in region about Brownsville, southwestern Texas.

TEXAS: black gumbo soil, Brownsville, *Runyon 295* (PO, US); northeast of Brownsville, Oct. 24, 1927, *Rose & Russell 24208* (US); in crawfish lands, gumbo soil, El Jardin to Point Isabel Road, Cameron Co., alt. 10 m., Aug. 5, 1923, *Runyon 506* (US TYPE).

**30. G. Hallii** Steyermark in Ann. Mo. Bot. Gard. **21:** 229. 1934.

*G. camporum* Greene acc. to Hall in U. Cal. Publ. Bot. [Compos. S. Cal.] **3:** 39. 1907, only as to plants of *Chandler 5460* and *Brandegee,* Cuyamaca Mts., July 8 and Oct. 15, 1894.

Herbaceous perennial, mostly with persistent basal rosettes of leaves; stems usually several, slender, corymbosely branched above with divergently ascending floriferous branchlets bearing numerous heads, glabrous, 2.5–6 dm. tall; leaves subcoriaceous, abundantly and conspicuously resinous-punctate, rather lustrous, serrulate or sharply serrate to entire, 1–7.5 cm. long, 0.2–1.2 cm. broad, 3–8 times longer than broad, oblong-oblanceolate to lanceolate, acute to obtuse, narrowed toward the base to (the upper) subamplexicaul, glabrous except for the minutely scabridulous surface; heads radiate, 1.5–2 cm. broad; disk campanulate-hemispherical, 0.7–1 cm. high, 0.8–1.7 cm. broad; involucre abundantly and conspicuously resinous, about 5-seriate, outer and middle bracts with short acute to acuminate flattened spreading deflexed or slightly reflexed tips, inner and often the middle with tips mostly erect, 2–8 mm. long, linear-lanceolate to lanceolate, glabrous; rays 10–20, the lamina 8–9 mm. long; stigmas narrowly oblong-lanceolate; achenes oblong, light brown or mostly stramineous, 4.5–5 mm. long, about 2 mm. broad, smooth to furrowed, conspicuously unidentate or knobbed at the apex or obliquely truncate; awns 2 to the floret, slender, entire to remotely serrulate, 2.5–4 mm. long, ½–¾ length of disk-floret.

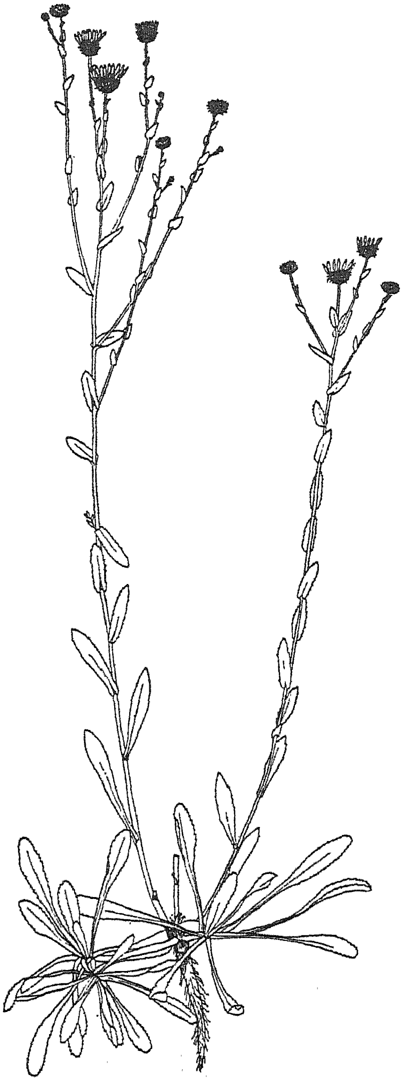

Fig. 25. *G. Hallii.* × ⅕.

Distribution: dry rocky slopes, ridges, and mesas in the region of Cuyamaca Lake and San Diego, southern San Diego Co., California.

CALIFORNIA: abundant about dam, Cuyamaca Lake, alt. 4600 ft., June 24, 1924, *Peirson 4825* (M, P); in woods at auto camp grounds, Cuyamaca Lake, San Diego Co., alt. 4700 ft., Sept. 5, 1932, *Peirson 10472* (E, P, PO); Julian-Cuyamaca, San Diego Co., Sept. 13, 1929, *Hoffmann* (SB); open meadows and dry slopes about Cuyamaca Lake, June 30, 1903, *Abrams 3957* (F, G, M, NY TYPE, PO); Cuyamaca, San Diego Co., July 8, 1894, *T. S. Brandegee* (CAL); Stonewall, Oct. 15, 1894, *T. S. Brandegee* (CAL); Julian, Nov. 11, 1929, *Woodcock 63* (CAL); near Julian, San Diego Co., Aug. 11, 1886, *Orcutt* (M, US); Julian, Cleveland National Forest, July 29–30, 1915, *A. S. Hitchcock* (US); Larkens, Aug. 18, 1875, *Ed. Palmer 128* (F, G, M, NY); Julian, San Diego Co., alt. 4200 ft., July 12, 1904, *Chandler 5460* (CAL, NY).

The involucral bracts in this species are mostly erect and appressed or slightly spreading at the tips, but in late maturity in some cases may become more recurved and spreading. Collections have been obtained from the region around San Diego, California, which are somewhat intermediate between, and may possibly represent hybrids of, *G. Hallii* and *G. rubricaulis* var. *elata*. *Grindelia Hallii* possesses leafy rosettes which remain attached at the base of the stem.

This species is named in honor of the late Dr. H. M. Hall of the Carnegie Institution. Dr. Hall's interest in this genus, to the extent of photographing types in foreign herbaria, obtaining fragments of the types, and in furnishing critical accompanying notes with the photographs, has been of inestimable aid to the writer.

**31. G. procera** Greene, Man. Bot. San Franc. Bay Reg. 172. 1894; Fl. Franc. pt. 4. 362. 1897; Jepson, Fl. W. Mid. Cal. 555. 1901; J. T. Howell in Madroño $2^2$: 21. 1931.

Herbaceous perennial; stems usually solitary, stout, paniculately to fastigiately much-branched with numerous elongated strongly ascending floriferous branchlets bearing many heads, white or stramineous, mostly scaberulent below, 1.2–3 m. tall; leaves subcoriaceous to submembranaceous, dark olive-green, abundantly resinous-punctate, dentate with rather short acute teeth, to serrulate, 2–8 cm. long, 0.4–3 cm. (sometimes up to 5) broad, mostly 3–7 times longer than broad, oblong-lanceolate to lanceolate and acute, slightly subamplexicaul to amplexicaul, glabrous (except the slightly scabridulous margins); heads radiate, mostly 2–3 cm. broad; disk depressed-hemispherical, rather umbonate at the base, 0.8–1 cm. high, 1.1–1.8 cm. broad; involucre slightly to moderately resinous, 4–5-seriate, the outer bracts with the upper third to fourth free and ascending to slightly deflexed, 3–8 mm. long, linear-lanceolate to lanceolate with acute to acuminate submembranaceous slender tips; receptacle conspicuously foveolate; rays mostly 32–44, bright yellow or lemon-yellow, the lamina 8–10 mm. long; stigmas linear-lanceolate; achenes narrowly or linear-oblong, 2–4 mm. long, 1.3–1.5 mm. broad, usually dull to fuscous-brown or occasionally stramineous, smooth to slightly striated or sometimes roughened, 2–3-knobbed or toothed at apex, or the crown or teeth not well developed; awns mostly 2–3, but often 5–6, slender, entire to remotely marked with short projections, 2.3–4 mm. long, ½–¾ length of disk-floret.

Distribution: plains and alluvial ground along the San Joaquin River from Sacramento to Fresno Co., and about lakes, springy ground and roadsides south in the valley to Kern Co., and to Rock Creek, San Gabriel Mountains, Los Angeles Co., southern California.

CALIFORNIA: Borden Highway, 1 mile west of Holt, San Joaquin Co., Sept. 28, 1930, *J. T. Howell 5511* (CAS, P); Lower Kaweah River Valley, near Visalia, Tulare Co., Aug. 21, 1895, *Dudley 1343* (ST); Huron to Lemoore, Kings Co., Sept. 24, 1920, *Abrams 7705* (ST); near Galt, Sacramento Co., Sept. 14, 1917, *Abrams 6751* (ST); river bottom, 1 mi. west of San Joaquin River bridge near Lathrop, San Joaquin Co., Oct. 11, 1930, *J. T. Howell 5550* (CAS, G, M); San Joaquin bridge, Sept. 9, 1901, *T. S. Brandegee* (CAL); Visalia, July 31, 1892, *T. S. Brandegee* (CAL); in dry flats along river, San Joaquin River at Valley Boulevard, Fresno Co., Oct. 22, 1925, *Peirson 6467* (P, PO); near highway, 1½ miles southeast of Modesto, Stanislaus Co., July 22, 1929, *J. T. Howell 4351* (CAS); Rock Creek, San Gabriel Mts., Los Angeles Co., alt. 4000 ft., Sept. 5, 1928, *Peirson 8190* (M, P); common in low ground near Hanford, June 20, 1901, *Kearney 58* (M, US); roadside near Mojave, Kern Co., Oct. 1, 1931, *Hoffmann* (SB); Porterville, Sept. 20, 1921, *Kelly* (CAS); Bakersfield, Sept. 28, 1910, *McGregor 6* (NY, ST); Buena Vista Lake, Kern Co., June 23, 1926, *Hart* (CAS).

From 1901, when Jepson included this species in his 'Flora of Western Middle California,' *G. procera* remained unrecognized as a valid species until 1931, when Mr. J. T. Howell[31] stated his positive opinion as to its validity. The present author has studied living and herbarium material of *G. procera* Greene, and finds himself in full agreement with Mr. Howell.

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[31] Howell, J. T. in Madroño $2^2$: 21. 1931.

It is a very distinct species, and the only possible reason that it has been ignored for 30 years is probably due to the state of confusion and misunderstanding existing in most of the species of *Grindelia*. That it is readily distinguished from *G. camporum*, with which most authors have confused it, may be discerned from an examination of a few of the characters stated in the key, as well as in the additional points of divergence given below. In *G. procera* the disk averages much smaller than in *G. camporum* and varieties (except *G. camporum* var. *parviflora*); the involucral bracts are shorter, less firm, and less thickened than in the *G. camporum* group (except *G. camporum* var. *parviflora*); the pappus awns average shorter (½–¾ the length of the disk-corolla) and are more slender than in *G. camporum*, and in *G. camporum* they usually equal or nearly equal the height of the disk-corolla; the leaf is much less firm than in *G. camporum*, irregularly crisped, and presents an uneven surface; the stems are usually solitary

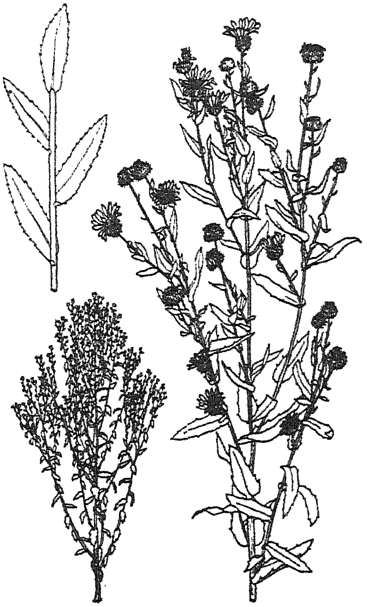

Fig. 26. *G. procera*, × ⅕; leaves × ⅕; habit × about 1/50.

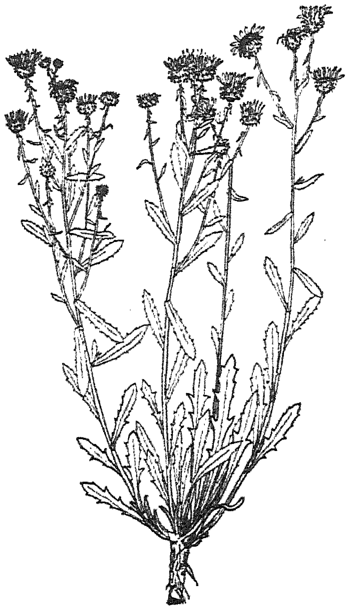

Fig. 27. *G. nana*. × ⅕.

and fastigiately branched with several or many closely ascending branches, whereas in *G. camporum,* including most of the varieties, the stems are usually several from the base and mostly corymbosely branched in the upper portions with elongated spreading-ascending floriferous branchlets. The base or the lower portion of the stem in *G. procera* is mostly finely puberulent, while it is glabrous (except the pubescent-stemmed varieties) in *G. camporum.* In the seedling stages the cotyledons are shorter and the rosette leaves shorter, narrower, and more pubescent in *G. procera* than in *G. camporum.* It is of interest, too, that the chromosome numbers differ; in *G. procera* we find a diploid with 6 and 12 chromosomes in the X and 2X number, respectively, while in *G. camporum* we encounter a tetraploid having 12 and 24 choromosomes respectively.

*Grindelia procera* is dominant in the upper San Joaquin Valley and the Tulare and Buena Vista Lake areas, and ranges north to the San Francisco Bay area where it reaches its northern limit in Marin Co. Around the lower San Joaquin and lower Sacramento Valleys *G. camporum* is dominant, and north of the lower San Joaquin Valley it is entirely replaced by its varieties, mostly *G. camporum* var. *Davyi.*

**32. G. humilis** Hook. & Arn. Bot. Beechey Voy. 147. 1833; DC. Prodr. **7**: 278. 1838; Torr. & Gray, Fl. N. Am. **2**: 248. 1842, as to name and bibliographical reference only; Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876; Syn. Fl. N. Am. **1**$^2$: 119. 1884, and ed. 2. 119. 1888; Greene, Fl. Franc. pt. 4. 363. 1897.

*G. robusta* Nutt. var. *angustifolia* Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876; Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as synonym of *G. cuneifolia.*

*G. cuneifolia* of most authors, not Nutt.; Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876, as synonym; Greene in Coulter's Bot. Gaz. **8**: 256. 1883; acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, in major part, and excluding plants from Santa Barbara; acc. to Greene, Man. Bot. San Franc. Bay Reg. 172. 1894, in major part; acc. to Greene, Fl. Franc. pt. 4. 363. 1897, in major part; acc. to Jepson, Fl. W. Mid. Cal. 555. 1901, and ed. 2. 462. 1911, in major part; acc. to Hall in U. Cal. Publ.

Bot. [Compos. S. Cal.] **3**: 38. 1907, as to description, excluding "bracts with tips . . . recurved" and plants from Los Angeles Co.; acc. to Perredes, Wellcome Res. Lab. Bull. 65: 4. *pl. 1. fig. 6.* 1907; acc. to Jepson, Man. Fl. Pl. Cal. 1021. 1925, in major part.

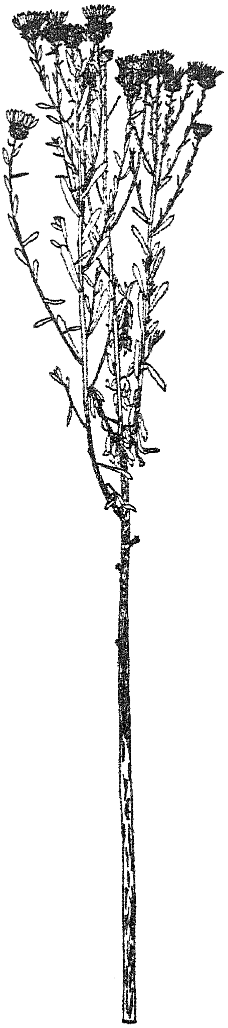

Fig. 28. *G. humilis.* × ⅕.

Almost fruticose perennial; stems woody up to about 1 meter, with 1 to several furrowed woody branches 5 cm. or less in diameter, giving rise each season mostly from above to subherbaceous shoots, below usually producing short leafy shoots, the entire plant up to 1½ m. tall, flowering shoots buff or dull brownish above, rufous-fulvous-brown below, glabrous, mostly paniculately branched with many elongated multiflorous branchlets; leaves coriaceous, dark olive or pale green, scarcely resinous, main cauline mostly remotely serrulate or crenate-serrulate with broad short teeth, to subentire, 1–8 cm. long, 0.1–1.4 cm. broad, 4–7 times longer than broad, oblong-oblanceolate, spatulate-oblong, lanceolate to linear, acute or obtuse, subamplexicaul or about as broad at the base as at the middle, glabrous; heads radiate, 3–4 cm. broad; disk campanulate-hemispherical, 0.8–1.3 cm. high, 1.2–2.2 cm. broad; involucre moderately resinous, 5–6-seriate, bracts usually erect and appressed, 3–8 mm. long, mostly lanceolate with acute to acuminate tips, the upper third to sixth free with usually straight short flattened, ascending to spreading, or slightly reflexed tips; rays 16–34, bright yellow or orange-yellow, the lamina narrowly oblong-spatulate, obtuse, mostly 12–17 mm. long; achenes oblong, grayish to fulvous-brown, 5–7 mm. long, 1.5–3 mm. broad, smooth to roughened or slightly winged on angles and dorsal face, at maturity undulately bordered at the apex with 2–3 broad coronal projections; awns 2–3 to the floret, mostly remotely serrulate to subentire, 3–5 mm. long, ⅔–¾ length of disk-floret.

Distribution: salt marshes, tidal flats and estuaries associated with *Salicornia ambigua*, common around the San Francisco Bay region, San Pablo Bay, Bolinas Bay, and north to Tomales Bay, western middle California.

CALIFORNIA: islands and coast of Bay, salt marshes, near San Francisco, 1866, *Kellogg* (G, US); salt marshes, Palo Alto, Sept. 19, 1915, *Stinchfield 252* (NY); salt marshes along the Bay of San Francisco, Oakland, Sept. 6, 1880, *Engelmann* (M); salt marsh, Kentfield, Marin Co., July 20, 1930, *Rose* in part (CAS, E); Palo Alto, Santa Clara Co., Sept. 14, 1901, *Baker 47* (CAL, CAS, G, M, MA, NY, PO, US); Cooley's Landing, San Mateo Co., near Palo Alto, Aug. 19, 1927, *Blake 10328* (G); San Francisco, 1868–9, *Kellogg & Harford 403* (G); salt marsh, Redwood City, San Mateo Co., Dec. 16, 1914, *Eastwood* (CAS); salt marshes, South San Francisco, San Mateo Co., Aug. 7, 1931, *Moore & Steyermark 3684* (M); salt marsh, near San Francisco, 1863, *Bolander 2425* (US); "California, *Hooker & Arnott* (Botany Beechey Voyage)" (CAL, G, US photograph of TYPE, G tracing of TYPE, CAL fragment of TYPE).

**32a. f. reflexa** Steyermark, f. nov.[32]

*G. cuneifolia* Nutt. acc. to Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 118. 1888, in small part, at least as to plant of *Greene* and excluding plants from Santa Barbara; acc. to Greene, Man. Bot. San Franc. Bay Reg. 172. 1894, in small part; acc. to Greene, Fl. Fran. pt. 4. 363. 1897, in small part; acc. to Jepson, Man. Fl. Pl. Cal. 1021. 1925, in small part.

Involucral bracts with tips more subulate and strongly reflexed or recurved to revolute, upper ⅓–⅜ free and reflexed for 1.5–4 mm. their length.

Distribution: San Francisco, San Pablo, Tomales, and Bolinas Bay region, often occurring with the species, mostly absent on the western portion of the San Francisco Bay, well developed in the Alameda and Oakland marshes.

CALIFORNIA: Alameda marsh, Aug. 7, 1921, *Eastwood 11049* (CAS COTYPE); tidal flat at mouth of Rodeo Creek, Contra Costa Co., Oct. 8, 1932, *J. T. Howell 10796* (CAS, M); Oakland salt marsh, Nov. 15, 1883, *Greene* (G TYPE); Alameda marshes, Nov. 12, 1904, *H. M. Hall 5720* in part (CAL, PO); vicinity of Berkeley, July–

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[32] **G. humilis f. reflexa** Steyermark, f. nov., bracteis involucri cum apicibus subulatioribus et valde reflexis vel recurvis.—Collected in Oakland salt marsh, Nov. 15, 1883, *E. L. Greene* (Gray Herb. TYPE).

Sept., 1906, *Walker 436* (CAL, PA, PO); salt marsh, 2 mi. west of Marin-Sonoma Co. line, Marin Co., at n. end of San Pablo Bay, Oct. 5, 1930, *J. T. Howell 5524* (CAS); near West Oakland, Sept., 1892; *Tidestrom* (CAL, MU).

**32b. f. pubescens** Steyermark, f. nov.[33]
Stems densely hirtellous-pubescent to villous.

Distribution: tidal flat on Napa River, Napa Co., and at Richmond Ferry, California.

CALIFORNIA: upper edge of tidal flat, Cuttings Wharf, on Napa River, Napa Co., Oct. 8, 1932, *J. T. Howell 10805* (CAS TYPE, M isotype); rocky clay bluff above Richmond Ferry slip, *McMinn 138* (ST).

It might be expected that the common plant of salt marshes of San Francisco Bay would have been properly identified before the present time, but heretofore all authors have referred it to *G. cuneifolia* Nutt. However, as will be presently shown, the proper name for this species must become *G. humilis* Hook. & Arn., while *G. cuneifolia* Nutt., not authors, becomes a synonym of *G. rubricaulis* var. *robusta* (*G. robusta*). The chief factor responsible for the misinterpretation of this species is the fragmentary condition of the type specimens of both *G. cuneifolia* and *G. humilis.* The present author has been able to identify both these fragments with certainty only after four years of monographic work on this group, which has involved a careful comparison of many specimens of herbarium and living material with the type collections of *G. humilis* and *G. cuneifolia.*

The description of *G. humilis* by Hooker and Arnott[34] was unfortunately based on a specimen less than a foot tall which supposedly had the "stems herbaceous." Since the common salt-marsh plant of San Francisco Bay has woody stems and is almost a fruticose type, its identity with *G. humilis* was never suspected, except by Greene[35] who, in his 'Flora Franciscana' in 1897, stated, at the end of his treatment of *Grindelia,* that

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[33] **G. humilis f. pubescens** Steyermark, f. nov., caulibus dense hirtello-pubescentibus vel villosis.—Collected at upper edge of tidal flat, Cuttings Wharf, on Napa River, Napa Co., California, Oct. 8, 1932, *J. T. Howell 10805* (Cal. Acad. Sci. Herb. no. 198266 TYPE, M isotype).

[34] Hooker, W. J. & Arnott, G. A. W., Bot. Beechey Voy p. 147. 1833.

[35] Greene, E. L., Fl. Franc. pt. 4. 363. 1897.

"*Grindelia humilis,* H. & A., is based on an abnormal twig broken off from a shrubby species and described as a small herb." Greene is to be praised for his keen insight into the situation here, because all other authors were unable to identify the fragmentary material. Gray,[36] in the 'Synoptical Flora,' had not the slightest idea of what constituted *G. humilis* and described it as a valid species under a separate section as, "anomalous and obscure species . . . ." Following his description, he added[37]: "Single specimen known, 'California, Beechey,' therefore probably from Monterey. Very unlike any other." There is no data on the type sheet of *G. humilis* to indicate whether Lay and Collie, who collected most of the plants on the Beechey expedition, obtained *G. humilis* at San Francisco or at Monterey Bay. However, on p. 134 of the 'Botany of the Beechey Voyage,'[38] under the heading "California," we find a short explanatory note as to localities where the Californian collections were taken, namely, "collected at San Francisco and a few at Monterey Bay." The author has made a study of a fragment and photograph of the type with accompanying notes obtained by the late Dr. H. M. Hall, of the Carnegie Institution, and preserved in the Herbarium of the University of California, and has been able to identify the type plant of *G. humilis,* fragmentary as it is, with the common salt-marsh plant of the San Francisco Bay. Fortunately, the single head preserved on the type shows the lanceolate, acute to acuminate, erect appressed involucral bracts characteristic of the common form of the San Francisco Bay species. The single pappus awn included in the preserved fragmentary material is subentire, which is characteristic of the salt-marsh plant of San Francisco Bay. An examination of many herbarium specimens of this species brings to light several collections in which the arrangement, size, and shape of the leaves match the type plant perfectly. This fragment, as Greene suggested, represents a broken-off herbaceous flowering branch from a taller suffruticose plant. Short lateral flowering shoots in this species are regularly produced from base to apex of the older ligneous portions, and to those acquainted with the habit of growth of this salt-marsh species the fragment collected by Lay and Collie is not unusual or even an abnormal shoot but one which might be collected at any time. Undoubtedly, this fragment of *G. humilis* was taken in the San Francisco region where the species in its typical form is common in salt marshes along the Bay, as at "South San Francisco," where the present writer first collected it. It was certainly never collected around Monterey Bay, as Gray assumed, since no species with the morphological characters of the *G. humilis* type specimen is known from that locality.

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[36] Gray, A., Syn. Fl. N. Am. $1^2$: 119. 1884, and ed. 2. 119. 1888.

[37] Gray, A. *Ibid.*

[38] Hooker, W. J. & Arnott, G. A. W., Bot. Beechey Voy. p. 147. 1833.

It is unfortunate that this species, one of the tallest (a meter or more tall) and the most fruticose of the genus, must bear the wholly inappropriate name, *G. humilis*.

33. **G. paludosa** Greene, Man. Bot. San Franc. Bay Reg. 172. 1894; Fl. Franc. pt. 4. 363. 1897.

*G. cuneifolia* Nutt. var. *paludosa* (Greene) Jepson, Fl. W. Mid. Cal. 556. 1901; Man. Fl. Pl. Cal. 1021. 1925.

Herbaceous perennial; stems subcorymbosely branched, buff or stramineous to suffused with pinkish-purple, glabrous, 0.5–1.5 m. tall; leaves subentire, remotely denticulate with broad short teeth, to coarsely and closely saliently or crenately dentate or serrate, broadly oblong or ovate to ovate-lanceolate or lanceolate, acute, strongly amplexicaul, the main middle and upper cauline 4–10 cm. long, 1.5–4.5 cm. broad, 2¼–4 times longer than broad, those on the floriferous branchlets 1.5–3.5 cm. long, 0.5–1.0 cm. broad, subcoriaceous, lower leaves produced on basal sterile or first-year shoots, entire to crenate near apex, broadly spatulate to obovate, narrowed but amplexicaul at base; heads radiate; disk campanulate-hemispherical, 0.7–1.1 cm. high, 0.8–2.0 cm. broad; involucre slightly to moderately resinous, the bracts with reflexed or deflexed to slightly revolute or sometimes spreading tips, glabrous, broadly lanceolate with rather abruptly acuminate to short caudate tips, or the outermost more narrowly lanceolate with short subulate tips, 5.5–20 mm. long; lamina of rays 12–18 mm. long, bright yellow or orange-yellow; achenes oblong, dull brown, 3.5–6.8 mm. long, 1.5–2 mm. broad, smooth to roughened on margins or angles; awns 2–5 to floret, subentire to remotely serrulate, 3–4.6 mm. long, ½–¾ length of disk-floret.

Distribution: brackish marshes about Suisun Bay and in vicinity of Suisun, western middle California.

CALIFORNIA: from the type plant in the Botanic Garden, Berkeley, Nov., 1894, *Davy* (CAL); from type plants, Bot. Garden, Berkeley, Nov. 7, 1895, *Jepson* (CAL, G, MU, NY, R); type locality, Suisun marsh along the railroad near Suisun, Sept. 21, 1904, *Heller 7542* (CAL, G, M, MA, NY, PA, US); Suisun marshes, Sept., 1897, *Davy* (CAL, PO); Suisun, Solano Co., alt. 10 ft., Oct. 9, 1932, *Booth 2063* (E); Suisun marsh, Sept. 29, 1889, and Oct. 30, 1892, *Greene* (N TYPE collection); Suisun marshes, Solano Co., Oct. 15, 1905, *Dudley* (ST); salt marsh, Suisun, Solano Co., Sept. 17, 1933, *J. T. Howell 11670* (CAS, M); salt marsh at Suisun, Solano Co., Nov. 19, 1933, *J. T. Howell 11724* (CAS, M); Suisun marshes at Pierce Station, Solano Co., Nov. 19, 1933, *J. T. Howell 11727* (M) and *11728* (CAS).

This entity has been much confused since its original publication in 1894. Although described[39] as a plant "about 5 ft. high, sterile leafy shoots a foot high or more, surviving the winter, the plant otherwise herbaceous," Greene nevertheless placed this species with the fruticose-stemmed *G. cuneifolia* of authors (*G. humilis* Hook. & Arn.), under the section "suffrutescent species." Examination of herbarium specimens of the type collection and of the plants cultivated from the type plants at the University of California Botanical Garden at Berkeley shows that the stems are herbaceous. Detailed field investigation of *G. paludosa* in the Suisun marshes, the type locality, graciously carried on by Mr. J. T. Howell, of the California Academy of Sciences, and the growing to maturity by the writer of several hundred plants from seed from various areas within the type locality prove definitely that the stems of this species are strictly herbaceous, arising directly from the crown of the perennial tap-root. In habit, therefore, this species is quite different from the woody-stemmed *G. humilis*, and cannot logically be considered a variety of that species, as some authors have done (calling it *G. cuneifolia* var. *paludosa*).

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[39] Greene, E. L., Man. Bot. San Franc. Bay Reg. 172. 1894; and Fl. Franc. pt. 4. 363. 1897.

It would seem that *G. paludosa* is of hybrid origin, and comprises within the Suisun marshes plants of varying degrees of hybridity. Many of the *G. paludosa* plants collected in this area appear to be hybrids between *G. camporum* and *G. humilis* f. *reflexa*, while others appear to be hybrids between *G. humilis* f. *reflexa* and *G. camporum* var. *parviflora*, or *G. camporum* var. *Davyi* and *G. humilis*, and still others between *G. procera* and *G. humilis* or f. *reflexa*. Most of the entities mentioned are found in the vicinity of the Suisun Bay and marshes. Mr. J. T. Howell has observed and collected both *G. camporum* and var. *parviflora* around this area in southern Solano Co. and Contra Costa Co. The collections of *G. camporum* (*J. T. Howell 4322* near Rodeo, *Rose's* collection of 1930 near Pittsburg, *J. T. Howell 11692* from Collinsville at edge of marsh), of *G. camporum* var. *parviflora* (*J. T. Howell 11721* from Ignacio, and *J. T. Howell 11729* from Benecia), and of *G. camporum* var. *Davyi* (*Rose's* collection of 1930 from Antioch Bridge) show that the species and vars. *parviflora* and *Davyi*, are at or near localities inhabited by *G. humilis* f. *reflexa*; and since *G. camporum* (for example, *J. T. Howell 11692* collection from Collinsville) and *G. camporum* var. *parviflora* (*J. T. Howell 11721* collection from Ignacio and *11729* from Benecia) may occur around brackish water in marshes which are inhabited by *G. humilis* f. *reflexa*, it is quite natural that hybrids should exist in these areas. Specimens of *G. paludosa* collected in the Suisun marshes by J. T. Howell (nos. *11723, 11724, 11726, 11727, 11670,* and *11671*) show various degrees of variation in leaf shape and serration. Some (no. *11723* and *11726*) have the leaves entire or subentire, exhibiting some of the *G. humilis* and f. *reflexa* ancestry, whereas others with more sharply serrate leaves show the dominance of the *G. camporum* character. The strongly amplexicaul bases of the upper leaves of some collections from the Suisun marshes (as one of the type collections made by Greene on Oct. 30, 1892, specimens collected from type plants by Jepson on Nov. 7, 1895, and by Burtt-Davy in Oct., 1895, *Heller 7542* and *Howell 11670*) manifest the *G. camporum* ancestry, while others with narrower upper leaves, not so conspicuously broadened at the base (as *J. T. Howell 11723* and *11671* and others) show more the *G. humilis* tendency. The collection of *J. T. Howell 11671* could be equally considered a hybrid between *G. humilis* and *G. procera* as it could between *G. humilis* f. *reflexa* and *G. camporum* var. *parviflora.*

*Grindelia paludosa* has leaves intermediate in texture between *G. humilis* and *G. camporum,* although the texture tends more towards the coriaceous type of *G. humilis.* The involucral bracts resemble in position, shape, length, and texture those of the *G. humilis* group more than *G. camporum.* The pappus awns, in their degree of remote serrulation, also suggest those of the *G. humilis* group. In the matter of the smaller degree of resinous output, *G. paludosa* shows a stronger resemblance to *G. humilis.*

Since it shows such points of resemblance to both the *G. humilis* and the *G. camporum* group, and in some characters is intermediate between the two although in most respects simulating more *G. humilis* and f. *reflexa,* and since it occurs in an area shared by both species, *G. paludosa* should be considered a youthful species of modern hybrid origin (Post-Pleistocene, because it inhabits brackish marshes not formed until after the drowning and subsidence of the lower San Joaquin and lower Sacramento Rivers, a process which has been going on into modern times). It is a nascent species, just beginning, sometimes appearing more like *G. camporum* and other times like *G. humilis.* Moreover, it cannot be considered a variety of either of these species, because it combines characteristics found in both.

**34. G. camporum** Greene, Man. Bot. San Franc. Bay Reg. 171. 1894; Fl. Franc. pt. 4. 361. 1897; Jepson, Fl. W. Mid. Cal. 555. 1901, and ed. 2. 462. 1911; Abrams, Fl. Los Ang. & Vic. 393. 1904, and ed. 2. 360. 1917, in large part, excluding plant from Wiseburn; Jepson, Man. Fl. Pl. Cal. 1021. 1925.

*G. robusta* var. *rigida* Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876, in part; Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 119. 1888, in part, as synonym of *G. robusta.*

*G. squarrosa* (Pursh) Dunal acc. to Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, in part, as to plants from California.

Herbaceous perennial; stems usually several, stout, corymbosely much-branched above the middle with strongly divergent ascending many-headed branchlets, usually white, stramineous or buff, glabrous, 0.5–1.5 m. tall; leaves subcoriaceous, dark green or bright green, conspicuously resinous-lustrous on the surface, mostly saliently dentate or serrate with sharp acute to subspinulose teeth, 0.7–9 cm. long, 0.4–3 cm. broad, 2–4 times longer than broad, obovate to broadly or ovate-oblong, subamplexicaul, those on the elongated floriferous branchlets much reduced, typically ovate or ovate-oblong to broadly oblong-lanceolate, acute to acuminate, strongly amplexicaul, glabrous (except for the scabridulous margins); heads radiate, 2.5–3.5 cm. broad; disk depressed-hemispherical, 0.8–1.5 cm. high, 1.1–2.5 cm. broad; involucre abundantly resinous, 5–6-seriate, bracts 6–11 mm. long, lanceolate with elongated subulate subterete thickened tips, the upper ⅓–⅝ of the bracts free and loosely spreading to deflexed; rays 18–39, bright yellow or lemon-yellow, the lamina 8–11 mm. long; stigmas linear or narrowly linear-lanceolate; achenes broadly oblong, 3–5 mm. long, 1.5–2.5 mm. broad, stramineous or dull brown, striated or irregularly furrowed or smooth, 2–3-knobbed, toothed, or auriculate at apex, these sometimes more prominent at one portion; awns 2–3 to the floret, stout, entire to subentire, 4–7 mm. long, ¾ to equalling length of disk-floret.

Distribution: alluvial river-bottoms, arid rocky flats, dry gravelly washes along creeks, dry clay slopes, and along roadsides, along the lower Sacramento River Valley region and the valley lands about San Francisco Bay, where common, southwards following the San Joaquin River and valleys to Mariposa and Tulare Counties, central California; introduced around Los Angeles, California, Nevada, and Pennsylvania.

PENNSYLVANIA (Introduced): on ballast, Philadelphia, Aug. 1878, 1879, and 1880, *Martindale* (MU, US), and June 13, 1880, *Martindale* (G); ballast, Philadelphia, June 13, 1880, *Parker 1285a* (M).

NEVADA: dry hills, vicinity of Austin, alt. 1950 m., July 25, 1913, *A. E. Hitchcock 661* (US).

CALIFORNIA: roadside, 6 miles west of Tracy, Contra Costa Co., alt. 50 m., Aug. 7, 1931, *Moore & Steyermark 3683* (M); Antioch, Sept. 5, 1881, *Greene* (M); Golden Gate Park, 1881, *Greene* (N); Monte Diablo, 1860–62, *Brewer 850* (G, US);

Antioch, June, 1884, *T. S. Brandegee* (CAL); clay soil on roadside, 4 miles west of Clayton, Contra Costa Co., Sept. 21, 1929, *J. T. Howell 4387* (CAS); San Joaquin Valley between Visalia and Exeter on Raweal Road, July 31, 1915, *Abrams 5393* (ST); Liberty School on Marsh Creek Road, Contra Costa Co., Sept. 28, 1930, *J. T. Howell 5459* (CAS); Pittsburg, Contra Costa Co., July 22, 1930, *Rose* (CAS); dry gravelly wash of Mocho Creek, Livermore Valley, Alameda Co., Oct. 16, 1932, *J. T. Howell 10827* (CAS, M); Banta, San Joaquin Co., Sept. 9, 1892, *Bioletti* (CAL); 1868–9, *Kellogg & Harford 404* (G, NY); Los Angeles, near U. C. L. A., on Berendo Street, Nov. 13, 1928, *J. T. Howell 4090* (CAL, CAS); Merced, July 26, 1923, *Eastwood* (CAS); alkali country, 3 miles southwest of Merced, Merced Co., May 9, 1925, *J. T. Howell 1015* (CAS).

34a. var. **parviflora** Steyermark, var. nov.[40]

Stems 1.1–1.8 m. tall, much-branched above with very elongated ascending many-headed branchlets; leaves conspicuously and abundantly resinous, lustrous, middle and upper saliently dentate, 1–6 cm. long, 0.5–2.5 cm. broad, 1½–3 times longer than broad, oblong to broadly oblong, obtuse to acutish, amplexicaul, those on floriferous branchlets saliently dentate or denticulate, ovate to broadly lanceolate, acute to obtuse; heads about 1.5 cm. broad; disk mostly 0.6–1.0 cm. high, 0.7–1.5 cm. broad; involucre conspicuously and abundantly resinous, the upper ⅓–⅕ of the bracts free and squarrose to slightly deflexed, lanceolate with acuminate to short subulate somewhat thickened and subcoriaceous tips; rays 16–18, the lamina 7–8 mm. long; achenes broadly oblong, 4–5.2 mm. long, 2–2.3 mm. broad, stramineous or light brown, conspicuously 2–3-knobbed, toothed or undulately bordered at apex; awns 3–4 mm. long.

Distribution: low or alluvial ground along streams and roadsides, Marin, Alameda, Contra Costa and Solano Counties, in region of San Francisco Bay, California.

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[40] G. **camporum** var. **parviflora** Steyermark, var. nov., caulibus 1.1–1.8 m. altis, robustis, supra valde ramosis, ramusculis elongatissimis, adscendentibus, multicapitulatis; foliis abundanter et valde resinosis, in ramusculis floriferis valde reductis, foliis mediis et superioribus 1–6 cm. longis, 0.5–2.5 cm. latis, 1½–3 plo longioribus quam latis, oblongis vel late oblongis, amplexicaulibus, salienter dentatis; capitulis ca. 1.5 cm. latis; disco plerumque 0.6–1.0 cm. alto, 0.7–1.5 cm. lato; involucro abundanter et valde resinoso, bracteis 3–7 mm. longis, parte superiore libera et squarrosa vel paullum deflexa; ligulis 16–18, 7–8 mm. longis; achaeniis late oblongis, 4–5.2 mm. longis, 2–2.3 mm. latis, apicibus 2–3-dentatis; aristis 3–4 mm. longis.—Collected at Liberty School on Marsh Creek Road, Contra Costa Co., California, Sept. 28, 1930, *J. T. Howell 5496* (Cal. Acad. Sci. Herb. no. 187935 TYPE, D, M, isotypes).

CALIFORNIA: Cedar Mt. Ridge, Alameda Co., Nov. 29–30, 1907, *Forbes* (CAL); Patterson Pass, east side, Contra Costa Co., Sept. 13, 1917, *Abrams 6727* (NY); Ignacio, Marin Co., Nov. 19, 1933, *J. T. Howell 11721* (M); Benecia, Solano Co., Nov. 19, 1933, *J. T. Howell 11729* and *11730* (M); low valley land, perhaps alkaline, Marsh Creek Road, 3.5 miles southwest of Brentwood, Sept. 21, 1929, *J. T. Howell 4396* (CAS); Liberty School on Marsh Creek Road, Contra Costa Co., Sept. 28, 1930, *J. T. Howell 5496* (CAS TYPE, D, M, isotypes).

**34b.** var **australis** Steyermark in Ann. Mo. Bot. Gard. **21**: 228. 1934.

*G. camporum* Greene acc. to Hall in U. Cal. Publ. Bot. [Compos. S. Cal.] **3**: 39. 1917, only as to plant of *Hall 6719* from Elizabeth Lake, Los Angeles Co.

Stems glabrous, 3–7 dm. tall, branched above with short rather closely ascending floriferous branchlets bearing few to many heads often crowded near the tips; leaves conspicuously resinous-punctate, the main middle and upper cauline saliently denticulate to spinulose-denticulate, 3–7 cm. long, 1–2.5 cm. broad, 2–4 times longer than broad, oblong or ovate-oblong to ovate, strongly amplexicaul; disk 1–1.3 cm. high, 1.2–2 cm. broad; involucral bracts strongly reflexed to revolute; lamina of ray-floret 7–9.5 mm. long.

Distribution: dry slopes and open banks, vicinity of Tehachapi Pass, Kern Co., and about Elizabeth Lake and Santa Susanna Mts., Los Angeles Co., southern California.

CALIFORNIA: Cameron, alt. 3800 ft., July 24, 1900, *M. E. Jones* (PO); Elizabeth Lake, Los Angeles Co., July, 1905, *Hall 6719* (CAL); base of dry slope, 3 miles east of Elizabeth Lake, Los Angeles Co., Sept. 4, 1928, *Munz & Johnston 11157* (PO TYPE); open bank, Elizabeth Lake, northern Los Angeles Co., July 9, 1928, *Hoffmann* (SB); Tehachapi Valley, Kern Co., alt. 1250 m., June 25, 1891, *Coville & Funston 1116* (US); Tehachapi Pass, Kern Co., June 28, 1905, *Grinnell 412* (US); Tehachapi, Kern Co., Sept. 29, 1894, *Eastwood* (G); Santa Susanna Mts., Los Angeles Co., June 16, 1916, *Moxley & Grinnell 495* (ST).

Aside from the more recurved or sub-revolute tips of the involucral bracts and more closely crowded heads on shorter branches, this variety resembles typical *G. camporum*.

**34c.** var. **abbreviata** Steyermark in Ann. Mo. Bot. Gard. **21**: 228. 1934.

Stem solitary, simple below, slightly branched near top with few short floriferous branchlets; leaves subcoriaceous, conspicuously resinous-punctate; disk small, 0.8–1 cm. high. 1–1.2 cm. broad; involucral bracts 2–8 mm. long, the tips only 1.5–2.5 mm. long, slightly spreading or ascending, lanceolate, acuminate to short-subulate; awns about 4 mm. long, ⅔–¾ length of disk-floret.

Distribution: vicinity of Lancaster, Los Angeles Co., southern California.

CALIFORNIA: alkaline flats, Lancaster, Los Angeles Co., Sept. 23, 1927, *Hoffmann* (SB TYPE).

**34d.** var. **Davyi** (Jepson) Steyermark, comb. nov.

*G. robusta* Nutt. var. *Davyi* Jepson, Fl. W. Mid. Cal. 554. 1901, and ed. 2. 462. 1911; Man. Fl. Pl. Cal. 1020. 1925.

*G. robusta* var. *rigida* Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876, in part; Syn. Fl. N. Am. $1^2$: 119. 1884, and ed. 2. 119. 1888, in part as synonym of *G. robusta.*

*G. squarrosa* (Pursh) Dunal acc. to Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 119. 1888, in part as to plants from California.

Stems usually several, generally more slender than in the species, sparsely corymbosely branched with ascending few-headed branchlets, purplish- or brownish-red to stramineous, glabrous, mostly 0.35–0.75 m. tall; leaves usually somewhat thinner than in the species, saliently serrate or dentate to subentire, 2–12 cm. long, 0.3–2 cm. broad, 4–10 times longer than broad, narrowly oblanceolate to oblong or oblong-lanceolate and acute, subamplexicaul, those on floriferous branchlets typically linear-oblong to lanceolate, not conspicuously reduced.

Distribution: dry grassy or rocky slopes in mountainous or hilly country, along creeks and river courses, dry fields and roadsides, northern and north-central California from Modoc Co. south along the western slopes of the Sierra Nevadas to Tulare Co., and along the Coast Range from Humboldt Co. south to Alameda and Contra Costa Co. and along the Sacramento River and its tributaries in northern California.

CALIFORNIA: Pachecos Pass near Camp 77, June 19, 1862, *Brewer 1290* (G, US); Berkeley, *King* (CAL); near Madison, Yolo Co., May 31, 1903, *Heller & Brown 5578* in part (G, PA); Mt. St. Helena at timber line, Sept. 23, 1893, *Jepson* (CAL); field, 2 mi. north of Placerville, Eldorado Co., Oct. 12, 1930, *J. T. Howell 5567* (CAS); Auburn, Placer Co., Oct., 1894, *Ames* (G); near Nevada City, Nevada Co., July 14, 1905, *Heller 8117* (CAL, D, F, G, M, NY, PA, US); near Gautier's Bridge over Bear River, Nevada Co., July 4, 1913, *Eastwood 3433* (CAS); Lawrence, July 6, 1882, *M. E. Jones 3611* (CAS, M, MA, NY, PO, US); Lakeport, June, 1885, *Rattan* (G); Payne Creek, Lassen Butte region, Tehama Co., Aug. 22–26, 1912, *Eastwood* (CAS); Red Bluff, June, 1917, *Wickes* (CAS); Little Chico Creek, June, 1897, *Austin 1953* (US); dry hillside at Little Chico Creek, alt. 2000 ft., July 5, 1900, *Leiberg 5023* (US); Durham, Butte Co., June 5, 1932, *Morrison* (CAS); Sacramento, Sacramento Co., May 10, 1918, *Hannibal* (ST); Montezuma Hills, Solano Co., Sept. 17, 1933, *J. T. Howell 11684* (CAS, M); east of Chiles Valley on road to Winters, Napa Range, Napa Co., Aug. 27, 1933, *J. T. Howell 11645* (CAS, M); Table Mountain Olive Ranch, north of Oroville, Butte Co., June 4, 1913, *Heller 10780* (CAL, F, G, M, NY, PA, US); Antioch Bridge, Contra Costa Co., July 22, 1930, *Rose* (CAL); Redding, Shasta Co., May 24, 1913, *L. E. Smith* (CAS, US); Kennett, Shasta Co., July 26, 1912, *Eastwood 1464* (CAS, US); valley flat, 5 mi. south of Garberville, Humboldt Co., June 16, 1931, *J. T. Howell 6713* (CAS); vicinity of Ione, Amador Co., alt. 200–500 ft., June, 1904, *Braunton 1007* (CAL, M, NY, US); Caminetti Ranch, near Jackson, Amador Co., alt. 1600 ft., June 1–20, 1904, *Mulliken 113* (CAL, PO, R, US); Murphy's, Calaveras Co., July 2, 1891, *T. S. Brandegee* (CAL); The Geysers, July 5, 1931, *M. E. Jones 29142* (CAL, M); Mark West Creek north of Santa Rosa, Sonoma Co., July 8, 1902, *Heller 5810* (F, G, M, NY, PA, US); in chaparral, 4 mi. from petrified forest on road to Knight's Valley, Sonoma Co., June 30, 1929, *J. T. Howell 4318* (CAS); Peralta Park, Berkeley, June 10, 1896, *Davy* (CAL COTYPE); N. Berkeley, Oct., 1897, *Davy* (CAL); Berkeley, Dec. 4, 1912, *Condit* (CAL).

In placing var. *Davyi* under *G. robusta*, Jepson added to the state of confusion already existing under *G. robusta*. Careful study of living and herbarium material, including the type collections of *G. robusta* var. *Davyi*, proves that this is a common and widespread variation of *G. camporum* which ranges northward from the San Francisco Bay region to northern California. It is unfortunate that Jepson should have based part of his interpretation of *G. robusta* var. *Davyi* on collections around the San Francisco Bay region, such as Davy's collections from Peralta Park, Berkeley, and Walker's *441*, because in this region hybridization takes place between *G. camporum* and var. *Davyi*, and some of the collections (such as *Walker 441*) used as part of a basis of Jepson's concept of var. *Davyi* are somewhat intermediate between *G. camporum* and var. *Davyi*, and may possibly be of hybrid origin. Farther north along the Sacramento River Valley and along the foothills of the Coast Range and western foothill slopes of the Sierra Nevada, the var. *Davyi* is the dominant and typical variation of the species. It is mostly distinguished from *G. camporum* by its fewer heads on more sparsely branched stems, and by the leaves which are much longer than broad, especially the upper ones, and from forms and varieties of *G. integrifolia* by the more squarrose bracts, the longer and stouter pappus awns which equal or almost equal the length of the disk-floret, and the more conspicuously knobbed achenes.

**34e.** var. **interioris** (Jeps.) Steyermark, comb. nov.

*G. rubricaulis* DC. var. *interioris* Jeps. Man. Fl. Pl. Cal. 1021. 1925.

*G. hirsutula* Hook. & Arn. acc. to Torrey in Whipple's Exp. Rept. Bot. no. 4. 43. 1857.

Similar to *G. camporum* var. *Davyi*, but stems and often the leaves and involucral bracts villous.

Distribution: dry open hillsides, wooded slopes, valley-land or sometimes along roadsides, occasional along the western slopes of the Sierra Nevadas, northern California, from Amador to Tuolumne Counties, along the Sacramento River Valley in Yolo, Glenn, and Colusa Counties, and Mendocino Co., and south in San Mateo, Sonoma, Santa Clara, and Fresno Counties.

CALIFORNIA: 2 mi. south of Arbuckle, Colusa Co., May 8, 1928, *Abrams 12585* (NY); Stanislaus River, 1853–4, *Bigelow* (NY, US); near Madison, Yolo Co., May 21, 1902, *Heller & Brown 5578* in part (F, M, MA, NY, PO, US); along the highway, 2 mi. south of Arbuckle, Yolo Co., May 12, 1928, *Heller 14557* (NY); Ukiah, Mendocino Co., June 13, 1913, *Eastwood 3317* (CAS); between Hamilton and Orland, Glenn Co., May 1, 1914, *Heller 11351* (CAL, CAS, F, G, M, MU, NY, PA, US); Amador Co., June, 1893, *Cannon* (CAS); Mokelumne Hill, Calaveras Co., May 18–30, 1895, *Davy 1383* (CAL TYPE); dry hillside, Jenny Lind, alt. 250 ft., May 12, 1928, *Stanford 969* (M); Howell Mt., July 19, 1907, *Chandler 7604* (CAL); New York Falls, Amador Co., alt 1000 ft., May 26, 1896, *Hansen 1672* (M, US); occasional in open wooded hills near French Flat, alt. 1400 ft., May 30, 1919, *Williamson 180* (CAS, NY, US); hills on trail to Pine Ridge, Fresno Co., May 29, 1893, *Dudley* (ST); Serpentine hills near Coyote, Santa Clara Co., May 18, 1918, *Ferris 828* (ST).

**34f.** var. **interioris f. foliacea** Steyermark, f. nov.[41]

Stems buff to salmon, villous-pubescent, especially in upper half; leaves submembranaceous, more or less villous-puberulent (the lower sometimes becoming glabrate), the main lower and middle cauline 5–11 cm. long, 1–1.7 cm. broad; involucral bracts glabrate to villous-hirsutulous, mostly broadly lanceolate with long flattened tips, especially the outer bracts generally becoming much elongated and foliaceous and widely spreading or descending; disk 1.2–1.6 cm. high, mostly 1.8–3.2 cm. broad; awns about as long as disk-floret, 6–8 mm. long.

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[41] **G. camporum** var. **interioris** f. **foliacea** Steyermark, f. nov., bracteis involucri omnibus laxis, exterioribus valde elongatis et foliaceis, late patentibus; disco 1.2–1.6 cm. alto, plerumque 1.8–3.2 cm. lato; aristis flores disci subaequantibus, 6–8 mm. longis.—Collected on clay hill, 1 mile from Vacaville on road to Elmira, Solano Co., California, May 30, 1930, *J. T. Howell 5201* (Cal. Acad. Sci. Herb. no. 179831 TYPE, E, G, PO, isotypes).

Distribution: clay hills and ridges, in vicinity of Vacaville, Solano Co., California.

CALIFORNIA: clay hill, 1 mile from Vacaville on road to Elmira, Solano Co., May 30, 1930, *J. T. Howell 5201* (CAS TYPE, E, G, PO); Vacaville, Solano Co., May 6, 1903, *Baker 2916* (CAL, CAS, F, G, M, NY, PO, US).

The production in *G. camporum* and varieties of much elongated and foliaceous outer bracts or of crowded leaves beneath the head is very characteristic, and plants of var. *interioris* f. *foliacea* grown from seed breed true and exhibit the characteristic foliaceous development of the bracts.

The series of variations within the *G. camporum* group is rather involved. *Grindelia camporum* and all varieties, except var. *interioris,* possess an abundance of resin in leaves and involucres, *G. camporum* having the most conspicuous output. The pappus awns of most of the *G. camporum* group nearly equal or surpass the length of the disk-corolla, and are usually decidedly paleaceous (stoutish), characters which should distinguish collections of the *G. camporum* group from any forms of *G. nana, G. rubricaulis* or *G. procera.* The elongated narrowly linear style-branches or stigmas found in the *G. camporum* group are also evident in *G. procera* and to some extent in *G. Hallii,* and should differentiate them from forms of *G. hirsutula* or *G. rubricaulis,* both of which possess less elongated and shorter more oblong or oblong-lanceolate stigmas. The elongated terete thickened spreading or deflexed tips of the involucral bracts of the *G. camporum* group are also very characteristic. Difficulty may sometimes exist in differentiating some forms of *G. camporum* var. *interioris* f. *foliacea* from those of *G. hirsutula* f. *patens* or f. *cacumena,* but if the important morphological characters distinguishing the *G. cam-*

*porum* group from the *G. hirsutula* group are considered, identification should follow readily.

*Grindelia camporum* var. *parviflora* probably represents a hybrid, or is of hybrid origin, between *G. camporum* and *G. procera;* both the latter species have been found in the area inhabited by *G. camporum* var. *parviflora*. *Grindelia cam-*

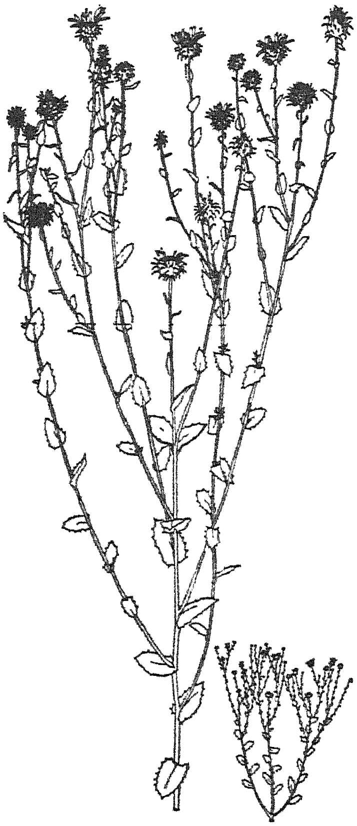

Fig. 29. *G. camporum.* × 1/6; habit × about 1/40.

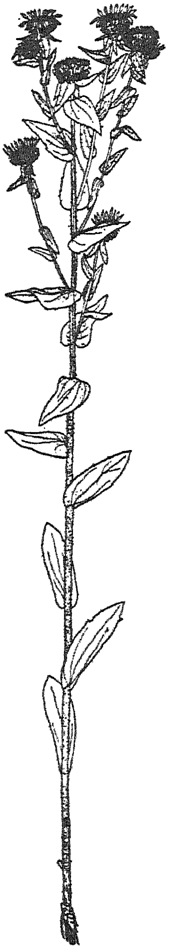

Fig. 30. *G. Howellii.* × 1/6.

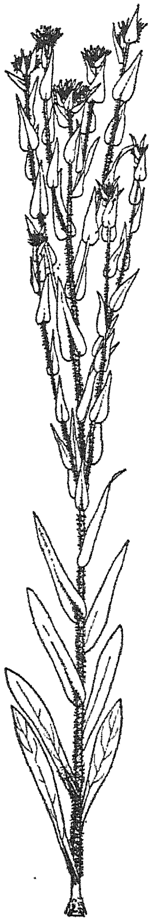

Fig. 31. *G. integrifolia.* × 1/6.

*porum* var. *parviflora* possesses the small heads of *G. procera,* but has the larger achenes, firmer resinous leaves, elongated inflorescence, and several or many spreading or divergently branching stems, all characters shared by *G. camporum.* Moreover, the shape and size of the cotyledons and size and serration of the young and basal leaves ally it to *G. camporum.*

35. **G. nana** Nutt. in Trans. Am. Phil. Soc. N. S. **7**: 314. 1841; Torr. & Gray, Fl. N. Am. **2**: 249. 1842, as synonym; Gray, Syn. Fl. N. Am. **1**$^2$: 119. 1884, and ed. 2. 119. 1888, in major part, excluding plants from northwest Wyoming, Idaho, Santa Cruz and Shasta, Cal., and *G. pacifica;* Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 556. 1906, excluding plants of *Henderson, Suksdorf, Elmer, Horner* and *Hardwick;* Henry, Fl. S. Brit. Col. 291. 1915, as to name and partly as to description; Piper & Beattie, Fl. N. W. Coast. 362. 1915, excluding plants from Willamette Valley; Jepson, Man. Fl. Pl. Cal. 1021. 1925, excluding plants from California.

*G. nana* β *integrifolia* Nutt. in Trans. Am. Phil. Soc. N. S. **7**: 314. 1841; Torr. & Gray, Fl. N. Am. **2**: 249. 1842, as synonym.

*G. humilis* Hook. & Arn. acc. to Torr. & Gray, Fl. N. Am. **2**: 248. 1842, at least as to "squarrose-recurved appendages," and excluding synonymy.

*G. humilis* α Torr. & Gray, Fl. N. Am. **2**: 249. 1842.

*G. humilis* β Torr. & Gray, Fl. N. Am. **2**: 249. 1842.

*G. squarrosa* var. *grandiflora* (Hook.) Gray acc. to Wats. Bot. U. S. Geol. Expl. 40th Par. [Bot. King's Exp.] **6**: 164. 1871.

Herbaceous perennial; stems several to many, subcaespitose, mostly slender, corymbosely much branched above the middle with numerous ascending floriferous branchlets, light brown to rose-purplish, glabrous, 0.8–6.5 dm. tall; leaves firmly membranaceous, abundantly and conspicuously resinous-punctate, entire to saliently dentate, those on the floriferous branches mostly entire, the main middle and upper cauline 3–9 cm. long, 0.4–2 cm. broad, the middle and lower cauline mostly 5–8 times longer than broad, oblanceolate or spatulate-lanceolate to (the upper) lanceolate, mostly attenuate to a narrowed base, 1–

5 mm. broad at the narrowest basal portion, glabrous; heads radiate, 2–3 cm. broad; disk mostly campanulate-hemispherical to deeply campanulate, 0.7–1.2 cm. high, 0.7–1.8 cm. broad, usually broader than high; involucre conspicuously and abundantly resinous, 5–7-seriate, the bracts 3.5–10 mm. long, lanceolate with subulate and thickened tips, the upper third to fifth strongly reflexed or revolute, 1–3 mm. long, glabrous; rays bright chrome- or lemon-yellow, 11–28, the lamina 5–11 mm. long; achenes narrowly oblong, 3.5–4 mm. long, about 1.5 mm. broad, smooth, light brown, when mature with 1–3 very short knobs or projections at apex; awns 2, slender, 3–5.5 mm. long, mostly entire to remotely serrulate, ⅔–⅞ length of disk-floret.

Distribution: dry rocky slopes and plains, frequently following river courses, also along roadsides, southern Washington east of the Cascades to northern and central Oregon locally southwest in Curry Co., Oregon, and northern Nevada.

NEVADA: Ruby Valley, alt. 6000 ft., Sept., 1868, *Watson 583* (G, NY, US).

WASHINGTON: roadside, 12 mi. northeast of Dayton, Columbia Co., Aug. 4, 1924, *Larkey* (WSC); Walla Walla, June 30, *Wilkes Exped.* (US); Bickleton, Aug. 1, 1929, *Gotfredson 95* (PO); Belmont, July 19, 1894, *Piper 1833* (R); wash, East Fork of Palouse River, Pullman, Whitman Co., July 17, 1919, *Ferris & Duthie 1269* (R, ST).

OREGON: La Grande, July 28, 1931, *Johnston* (CAS); 8 mi. west of Wapinitia, Wasco Co., June 24, 1928, *Thompson 4945* (M, PA, US); about 2 mi. west of Prairie City, along highway, July 15, 1926, *Babcock & Collins 84* (CAL); bank of John Day River, Clarno, Wasco Co., July 3, 1921, *Peck 10001* (NY); Blue Mts., July, 1902, *Griffiths & Hunter* (NY); dry hillsides, Pelican City, Klamath Co., *Evans 387* (UO); Klamath Falls, 1927, *Lawrence* (O); hot rocky slope at Maupin, Wasco Co., July 3, 1931, *J. T. Howell 7182* (CAS); gravelly hills near Prairie City, Grant Co., July 22, *Cusick 2185* (CAL, F, G, M, MA, MU, PO, R, US); dry situations, eastern Oregon, July 26, 1898, *Cusick 2058* in part (CAL, G, M, MA, MU, PO, US); on rocky lava soil with *Artemisia*, 15 mi. south of Maupin, Wasco Co., alt. 735 m., Aug. 10, 1931, *Moore & Steyermark 3688* (M); roadside, Telocaset, Union Co., July 25, 1921, *Peck 10426* (NY); Vancouver, *Nuttall* (G, PA TYPE collection); Tygh, Tygh Creek, Wasco Co., July 28–30, 1922, *Abrams 9530* (M, PO, R); Wallowa River, 1–6 miles above Minam River, alt. 2925 ft., Aug. 14, 1897, *Sheldon 8699* (M, NY, US); gravel bar along Rogue River, above Gold Beach, Curry Co., June 17, 1926, *Peck 14645* (WI).

35a. f. **Brownii** (Heller) Steyermark, comb. nov.

*G. nana* Nutt. acc. to Gray, Syn. Fl. N. Am. 1$^2$: 119. 1884, and ed. 2. 119. 1888, only as to plant from Idaho (*Wilcox*).

*G. Brownii* Heller in Bull. Torr. Bot. Club **26**: 315. 1899.

Stems taller and stouter than in the species, 5–8 dm. tall; leaves on the floriferous branchlets not so reduced as in *G.*

*nana*, entire or sparsely serrulate to dentate, the main middle and upper cauline 4–8 cm. long, 0.7–2 cm. broad, the middle and lower cauline 3–6 times longer than broad, the upper broadly lanceolate or oblong-lanceolate with conspicuous subamplexicaul base, the main cauline leaves 4–10 mm. broad at the narrowest basal portion; disk 0.7–1.7 cm. high, 1.2–2.2 cm. broad.

Distribution: dry rocky basalt and granite slopes of canyons and streams, roadsides and along roadside ditches, eastern Washington, Oregon, Idaho, northern Utah, and western Montana.

MONTANA: Crow Creek, July 31, 1900, *Elrod et al* (NY); near Stevensville, Bitter Root Forest Reserve, alt. 1100 m., Aug. 17, 1897, *Leiberg 2903* (US); dry hillsides, Lolo Valley near Lolo, Aug., 1912, *Kirkwood 81* (M).

IDAHO: dry sandy banks of the Clearwater River, below Lapiosi, July 9, 1898, *Henderson 4605* (G); dry clay slope, Salmon, Lemhi Co., alt. 4500 ft., July 3, 1920, *E. B. & L. B. Payson 1883* in part (CAS, R); common at Gilman Ranch, west of Hailey, July 27, 1909, *Woods & Tidestrom 2523* in part (US); Idaho Falls, July 17, 1893, *Ed. Palmer 359* (US); Salmon River bridge, alt. 2600 ft., July 1, 1895, *Henderson 3026* (CAS, US); Blackfoot, Aug., 1892, *Mulford* (M); dry lava soil slopes, Sweet, Boise Co., alt. 3500 ft., Aug. 14, 1911, *Macbride 1652* in part (M, MU, NY, US); Boise City, 1881, *Wilcox* (G); Council, Washington Co., alt. 3000 ft., Aug. 4, 1899, *M. E. Jones* (PO); east of Preston, June 20, 1930, *Davis* (IS); about forest, Nez Perces Co., alt. 3500 ft., July 14, 1896, *A. A. & E. G. Heller 3418* (CAL, M, MA, MU, NY, US, isotypes).

UTAH: Aug. 20,——, Cache Co., *collector lacking* (M); dry lake, Cache Co., Aug. 14, 1929, *Garrett 5380* (GA); dry lake, Cache Co., Aug. 7, 1933, *Garrett 6462* (GA).

WASHINGTON: rocky soil at ferry over Snake River, Franklin Co., alt. 210 m., Sept. 18, 1894, *Leiberg 930* (CAL, G, NY, US).

OREGON: near Echo, Umatilla Co., alt. 320 m., Sept. 16, 1894, *Leiberg 907* in part (G); railroad yards, Albina, July 22, 1917, *J. C. Nelson 1745* (G); along state highway, 15 mi. north of Maupin, Wasco Co., alt. 750 m., Aug. 10, 1931, *Moore & Steyermark 3689* in part (M); bank of Columbia River, near mouth of Des Chutes River, July 30, 1914, *Peck 4910* (WI).

### 35b. f. **longisquama** Steyermark, f. nov.[42]

*G. oregana* Gray, Syn. Fl. N. Am. $1^2$: 118. 1884, and ed. 2. 118. 1888, as to plants of *Nuttall* in Gray Herb. and of *Spalding*.

Stems corymbosely branched, 3.3–6 dm. tall; leaves entire to remotely serrulate or denticulate, the upper broadly lanceolate or oblong, subamplexicaul, narrowed to 1–7 mm. at the narrowest basal portion; disk mostly quadrate-hemispherical to deeply campanulate, 1.0–1.5 cm. high, 1–2 cm. broad, mostly as high as broad; involucral bracts 5–14 mm. long, the upper half to third free and strongly reflexed or revolute with tips 3–5 mm. long, the inner 10–14 mm. long with conspicuously elongated subulate or filiform free recurved tips; ligules 8–12 mm. long.

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[42] **G. nana f. longisquama** Steyermark, f. nov., foliis integris, denticulatis vel remote serrulatis, caulinis superioribus late lanceolatis vel oblongis cum basi subamplexicaule; disco quadrato-hemispherico vel profunde campanulato, 1–1.5 cm. alto, 1–2 cm. lato; bracteis involucri cum apicibus liberis, 3–5 mm. longis, parte libera laxa recurva vel valde reflexa.—Collected at Clearwater, Oregon (now Idaho), *Rev. Spalding* (Gray Herb. TYPE, NY isotype).

Distribution: dry rocky slopes, western Montana, central Washington, eastern Oregon, and Idaho.

Montana: dry southern slopes, pine woods, Lolo Valley, Aug., 1912, *Kirkwood* (CAL).

Idaho: hillsides, Squaw Butte, Boise Co., alt. 3500 ft., Aug. 18, 1911, *Clark 270* (CAL, F, G, M, MU, NY, PO, R, US); dry lava soil slopes, Sweet, Boise Co., alt. 3500 ft., Aug. 14, 1911, *Macbride 1652* in part (CAL, F, G, PO); hillsides, Big Willow, Canyon Co., alt. 3000 ft., May 28, 1910, *Macbride 126* (M, R); stony land, Clearwater, July 4, *Rev. Spalding* (G type, NY).

Washington: dry ground, Taneum Creek, Kittitas Co., Aug. 6, 1927, *G. N. Jones 639* (US).

Oregon: *Nuttall* (G); near Echo, Umatilla Co., alt. 320 m., Sept. 16, 1894, *Leiberg 907* in part (CAL, NY, US); Blue Mts., 9 mi. w. of Meacham, Umatilla Co., June 22, 1926, *Brunet* (ST); 2 mi. east of Pendleton, Umatilla Co., June 29, 1926, *Brunet* (ST).

### 35c. var. **altissima** Steyermark, var. nov.[43]

*G. nana* Nutt. acc. to Jepson, Man. Fl. Pl. Cal. 1021. 1925, as to plants from California, in part.

Stems one to few, glabrous, 4–11.5 dm. tall, the sparsely corymbosely branched floriferous branchlets elongated, few-headed; leaves entire or subentire, oblong-lanceolate to lanceolate, acute, mostly the same width at the base as at the middle, the main cauline leaves narrowed to 3–5 mm. broad at the narrowest basal portion, glabrous; disk campanulate-hemispherical, 0.9–1.1 cm. high, 1.3–1.8 cm. broad, broader than high; involucre with the upper fourth to half of the bracts strongly revolute or strongly reflexed with short subulate tips mostly 1.2–3 mm. long.

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[43] **G. nana** var. **altissima** Steyermark, var. nov., caulibus 4–11.5 dm. altis; ramusculis floriferis parce corymboso-ramosis, adscendentibus, elongatis; capitulis paucis, remotis; foliis integris vel subintegris (remote denticulatis); disco campanulato-hemispherico, 0.9–1.1 cm. alto, 1.3–1.8 cm. lato, latiore quam altio.—Collected on gravel bar, Eel River, at mouth of Laribee Creek, Humboldt Co., California, alt. 200 ft., Sept. 12, 1915, *J. P. Tracy 4669* (U. Cal. Herb. no. 186459 type, US isotype).

Distribution: along creek beds, alluvial ground, and in vicinity of mountains, southwestern Oregon south along the Coast Range country to Napa Range, Napa Co., California.

OREGON: Linkville, Aug. 27, 1897, *Austin 1614* (PO, US); Oregon, 1893, *Austin* (CAL); sandbar, 2 mi. above mouth of Rogue River, July 8, 1919, *Peck 8712* (WI); Mule Creek, Rogue River Canyon, Curry Co., Aug. 13, 1913, *Peck 4912* (WI); Roseburg, June 21, 1916, *Peck 4917* (WI); Umpqua valley, June, 1887, *T. Howell* (O).

CALIFORNIA: on gravel bar, Eel River, at mouth of Laribee Creek, Humboldt Co., alt. 200 ft., Sept. 12, 1915, *Tracy 4669* (CAL, US); Round Valley, Mendocino Co., alt. 440 m., July 20–Aug. 3, 1897, *Chestnut 547* (US); Mount Shasta and vicinity, Siskiyou Co., July 13–27, 1892, *Ed. Palmer 2551* (US); Sisson, Aug. 14, 1903, *Copeland 3884* (CAL, CAS, F, G, M, NY, PO); flood bed of Pope Creek, 1 mile below Samuels Springs, Napa Range, Aug. 4, 1929, *J. T. Howell 4361A* (CAS); Pine Hills, July 29, 1915, *Collins & Kempton 261* (US); Pacific Valley, *T. S. Brandegee* (CAL); Hornbrook, July, 1889, *K. Brandegee* (CAL); Susanville, June 30, 1892, *T. S. Brandegee* (CAL); Ager, July, 1887, *T. S. Brandegee* (CAL); Goose Lake Valley, Modoc Co., Aug., 1886, *Austin* (CAL); Goose Lake Valley, July, 1895, *Austin 572* (PO, US); Little Hot Spring Valley, Modoc Co., Aug. 18, 1899, *M. S. Baker* (PO).

### 35d. var. **altissima** f. **puberula** Steyermark, f. nov.[44]

Stems and leaves puberulent.

Distribution: near Ashland, Jackson Co., Oregon, and Lake Co., California.

OREGON: Ashland-Klamath Falls Highway, coming down grade towards Ashland from Green Spring's Mt., July 10, 1930, *Henderson 13001* (UO); hills near Ashland, July 8, 1886, *Henderson* in part (UO); Ashland, July, 1887, *T. Howell 741* in part (UO).

CALIFORNIA: dry roadsides, Kelseyville, Lake Co., June 12, 1924, *Blankinship* (CAS TYPE); along streams, Kelseyville, Cold Creek, Lake Co., July 3, 1929, *Blankinship* (M); between Clear Lake and Lower Lake, Lake Co., dry hillside, alt. 1500 ft., May 30, 1926, *Kildale 2065* (ST).

### 35e. var. **turbinella** Steyermark, var. nov.[45]

*G. nana* Nutt. acc. to Jepson, Man. Fl. Pl. Cal. 1021. 1925, as to plants from California, in part.

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[44] **G. nana** var. **altissima** f. **puberula** Steyermark, f. nov., caulibus foliisque puberulis.—Collected on dry roadsides, Kelseyville, Lake Co., California, June 12, 1924, *J. W. Blankinship* (Cal. Acad. Sci. Herb. no. 165247 TYPE).

[45] **G. nana** var. **turbinella** Steyermark, var. nov., caulibus fastigiate ramosis; foliis integris vel subintegris, caulinis 4.5–7 cm. longis, 0.8–1.1 cm. latis; capitulis parvis; disco turbinato vel profunde campanulato, 0.7–1.1 cm. alto, 0.65–1.1 cm. lato; ligulis 8–10 mm. longis.—Collected in gravelly soil at base of hill, Shasta Valley, 10 miles south of Gazelle, Siskiyou Co., alt. about 3000 ft., Sept. 7, 1917, *Heller 12579* (Gray Herb. TYPE, CAL, CAS, M, NY, US, isotypes).

Stem solitary, stout, usually fastigiately branched with numerous strongly ascending elongated branchlets, glabrous or infrequently villous-pubescent, 3.5–4.3 dm. tall; leaves essentially entire throughout or subentire, the main cauline 4.5–7 cm. long, 0.8–1.1 cm. broad, mostly 6–7 times longer than broad, narrowly oblanceolate, all attenuated at the base, the middle and lower cauline subpetiolate, glabrous; heads numerous, crowded, 1.2–1.5 cm. broad; disk turbinate or deeply campanulate, 0.7–1.1 cm. high, usually 0.65–1.1 cm. broad, as high as or higher than broad; involucre abundantly resinous, conspicuously imbricated, 6–8-seriate, the upper third to fifth of the bracts free and closely revolute, 3–8.5 mm. long.

Distribution: low open ground, Siskiyou Co., California to southwestern Oregon.

OREGON: Waldo, July 6, 1887, *T. Howell 742* (G); Kerbyville, July 10, 1887, *T. Howell 2868* (CAL); near New Pine Creek, Lake Co., alt. 1300 m., July 31, 1896, *Coville & Leiberg 130* (US).

CALIFORNIA: dry land, roadside near Montague, Siskiyou Co., Sept. 25, 1908, *Butler 499* (CAL); Verdi, Sept. 1888, *T. S. Brandegee* (CAL); Montague, Siskiyou Co., Aug. 13, 1913, *L. E. Smith 514* (CAS, G, US); Forestdale, Modoc Co., 1898, *M. S. Baker* (CAL); near Edgwood, June 28, 1889, *Lemmon* (CAL); near Yreka, Siskiyou Co., Aug. 12, 1876, *Greene 974* (F, G, M); Shasta Valley, 10 miles south of Gazelle, in gravelly soil at the base of a hill, alt. about 3000 ft., Sept. 7, 1917, *Heller 12979* (CAL, CAS, G TYPE, M, NY, PA, US).

35f. var. **integerrima** (Rydberg) Steyermark, comb. nov.

*G. integerrima* Rydb. in Bull. Torr. Bot. Club **37**: 128. 1910; Fl. Rocky Mts. 848. 1917.

Stems slender, subcaespitose, 1.5–4 dm. tall; leaves entire to saliently dentate, the main lower and middle cauline oblanceolate to lanceolate-spatulate, narrowed and attenuated at the base; disk small, campanulate-hemispherical, 0.6–1.0 cm. high, 0.6–1.3 cm. broad, mostly broader than high; involucre 5–6-seriate, bracts mostly 2–7 mm. long, lanceolate, the upper fifth to seventh strongly revolute into acuminate or short subulate tips 0.4–1.5 mm. long; awns 2.5–4.5 mm. long.

Distribution: sandy open ground and along sandy roadsides, north- and central-eastern Washington, northern Idaho, northwestern Montana and eastern Montana (where probably introduced).

MONTANA: Whitefish, Sept. 15, 1908, *M. E. Jones 8517* in part (US); St. Ignatius Mission, alt. 2800 ft., Sept. 4, 1908, *M. E. Jones 8517* in part (PO); sandy soil, Glendive, Sept., 1892, *Sandberg* (F, MU, R).

IDAHO: sandy soil near Granite Station, Kootenai Co., July 29, 1892, *Sandberg, MacDougal & Heller 784* (CAS, F, G, M, NY TYPE, PA); in the Palouse country and about Lake Coeur d'Alene, July, 1892, *Sandberg* (MU); city limits, Coeur d'Alene, June, 1912, *Rust 223* (US).

WASHINGTON: dry borders of Hangman Creek, Spokane, Spokane Co., July 9, 1892, *Henderson* (UW); near Spangle, Spokane Co., June 28, 1884, *Suksdorf 333* (G, PA, US); sandy open ground, near Spokane, Spokane Co., July 13, 1930, *E. J. Palmer 37831* (M, US); dry ridge, West Medical Lake, Spokane Co., Sept. 28, 1924, *St. John & Warren 6764* (PO); Spokane, Spokane Co., Sept. 5, 1912, *Turesson* (R); Spokane, July, 1898, *Savage, Cameron & Lenocker* (F, M).

OREGON: Union Co., *Cusick 505* (G, US); eastern Oregon, July 26, 1898, *Cusick 2058* in part (F).

35g. var. **Paysonorum** (St. John) Steyermark, comb. nov.

*G. Paysonorum* St. John in Res. Stud. State Coll. Wash. **12**: 108. 1929.

Stems several, 2.8–4.4 dm. tall; leaves mostly entire or subentire to remotely and shallowly denticulate, the main middle and upper cauline 5–8 cm. long, 1–2.3 cm. broad, 3–5 times longer than broad, the main lower and middle cauline elliptical-obovate or broadly oblong-oblanceolate to oblanceolate, acutish to obtuse, narrowed to a slender or broad base, 2–7 mm. broad, the upper only slightly reduced in size, broadly subelliptic-oblong to broadly oblong-lanceolate, acute, subamplexicaul to strongly amplexicaul; disk campanulate-hemispherical, 0.9–1.2 cm. high, 1.5–2.2 cm. broad, broader than high; involucre with mostly the upper ⅓–¼ of the bracts free and moderately to strongly revolute with a tip 1.5–3 mm. long; ligules mostly 10–14 mm. long.

Distribution: dry, sandy or limey soil, central and west-central Idaho, and sparingly in eastern Oregon and Washington.

IDAHO: sandy hillside, Lime Pt., T32N, R5W, Nez Perce Co., alt. 900 ft., May 9, 1926, *Ransom & Ridout 158* (WSC); dry ground, Lime Pt., T32N, R5W, Nez Perce Co., alt. 900 ft., May 9, 1926, *St. John 4361* (WSC TYPE); dry basalt walls of Snake River Canyon, s. of Zaza, Craig Mts., Nez Perce Co., T31N, R4W, alt. 4800 ft., Oct. 9, 1927, *St. John 9103* (WSC); common at Gilman Ranch, west of Hailey, July 27, 1909, *Woods & Tidestrom 2523* in part (US); dry clay slope, Salmon, Lemhi Co., alt. 4500 ft., July 3, 1920, *E. B. & L. B. Payson 1883* in part (G, M, NY).

WASHINGTON: 5 mi. east of Reardan, Lincoln Co., alt. 856 m., Aug. 14, 1931, *Moore & Steyermark 3690* (M).

OREGON: on rocky lava soil with *Artemisia*, 15 mi. south of Maupin, Wasco Co., alt. 735 m., Aug. 10, 1931, *Moore & Steyermark 3688* (M).

In describing *G. nana* Nuttall[46] stated that it was nearly allied to *G. humilis* Hook. & Arn. A year later Torrey and Gray,[47] evidently having a poor understanding of the species in this group, attempted to identify Nuttall's wholly distinct *G. nana,* including the spinulose- and entire-leaved forms, from near Fort Vancouver, Oregon, with the entirely different Californian *G. humilis* Hook. & Arn. Gray[48] later clarified this enigma by treating *G. nana* as a distinct species from *G. humilis* Hook. & Arn., and the "G. humilis" Torr. & Gray, not Hook. & Arn., became a synonym of *G. nana* Nutt. However, the plant with spinulose-toothed leaves which Nuttall described as the type of *G. nana* from Fort Vancouver, as seen on the lower right corner of the sheet in the Gray Herbarium, is a depauperate specimen with short-tipped involucral bracts, not at all typical of the commoner *G. nana* of that portion of Oregon and Washington; in fact, it much more resembles plants of *G. integerrima* Rydb. which has short-tipped bracts. Granting that Nuttall's specimen was a depauperate individual of the common form in the vicinity of Fort Vancouver and adjacent area and that his β *integrifolia* has the longer bracts typical of the *G. nana* form common in that portion of Oregon and Washington, we should take for the historical *G. nana* the common plant of that portion of Oregon and Washington with longer-tipped bracts, similar to Nuttall's *G. nana* β *integrifolia,* and retain the *integerrima* Rydb. as a variety of *G. nana* for those plants with very short-tipped involucral bracts, occurring in parts of Montana, northern Idaho, north- and central-eastern Washington and adjacent eastern Oregon.

The very confused concept of *G. oregana* Gray, which many authors have attempted to identify with a coastal species ranging from Alaska to California (*G. stricta* DC.), was based in part on material collected in Oregon by Nuttall and from Clearwater, Idaho, by Rev. Spalding; these collections are now included under *G. nana* f. *longisquama.* Since Gray's *G. ore-*

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[46] Nuttall, T., in Trans. Am. Phil. Soc. N. S. 7: 314. 1841.

[47] Torrey, J. & Gray, A., Fl. N. Am. 2: 248–9. 1842.

[48] Gray, A., Syn. Fl. N. Am. $1^2$: 119. 1884, and ed. 2. 119. 1888.

*gana* consisted of such confused elements, as to description, bibliography, synonymy, and specimens labelled and cited *G. oregana*, and since it does not lend itself to clear analysis, it is thought best to treat this name in the sense of a *nomen confusum*, and thus prevent any further distortion in taxonomic delimitation.

36. **G. Howellii** Steyermark, sp. nov.[49]

Stems stout, pale rose-purplish to buff, angled or grooved (especially above), subfastigiately branched above with stoutish somewhat elongated foliose floriferous branchlets bearing several heads, glandular and villous, predominantly glandular, 6.5–8 dm. tall; leaves thin and membranaceous, pale green, scarcely resinous-punctate, the surface mostly dull, remotely dentate or denticulate to entire, the main middle and upper cauline 2.5–7 cm. long, 0.7–2.2 cm. broad, 3–3½ times longer than broad, oblong to broadly oblong-ovate to ovate-lanceolate, acute to acutish, strongly amplexicaul, those on floriferous branchlets numerous, enlarged, and conspicuous beneath the heads, minutely but rather densely glandular or glandular-puberulent; heads radiate, 2.5–3 cm. broad; disk campanulate-hemispherical, 1.1–1.3 cm. high, 1.5–3 cm. broad; involucre moderately resinous, 6–7-seriate, very conspicuously graduated, bracts linear-lanceolate to lanceolate with subulate subterete thickened tips, 3.5–10 mm. long, the upper fourth to fifth free and conspicuously revolute or recurved, the outermost crowded at the base, glabrous; rays 20–28, rather dull yellow or lemon-yellow, the lamina 9–10 mm. long; achenes oblong, 3.5–4.3 mm. long, 1.5–2 mm. broad, stramineous, stri-

[49] **G. Howellii** Steyermark, sp. nov., caulibus glanduloso-villosis; foliis tenuibus et membranaceis, pallide viridibus, parce resinoso-punctatis, valde amplexicaulibus, illis in ramusculis floriferis parce denticulatis vel integris, ceteris remote dentatis vel denticulatis, caulinis superioribus oblongo-ovatis vel ovato-lanceolatis, acutis, caulinis mediis oblongis, minute sed dense glandulosis vel glanduloso-puberulis; involucro moderatim resinoso, 6–7-seriato, bracteis subteretibus, glabris, parte superiore libera et valde revoluta vel recurvata; aristis 2, plerumque integris vel subintegris, 4–5 mm. longis, disci flores in longitudine ½–⅔ aequantibus.—Collected on dry arid bluff tops, St. Máries River, Kootenai Co., Idaho, Aug. 10, 1894, *L. F. Henderson 2791* (Gray Herb. TYPE, R, US, isotypes).

ated or ribbed on the faces, mostly truncate at apex; awns mostly 2 to the floret, slender, entire to remotely serrulate, 4–5 mm. long, ½–⅔ length of disk-floret.

Distribution: dry rocky bluffs, along St. Maries River, Kootenai Co., Idaho.

IDAHO: very dry rocky bluffs and dry arid level bluff tops, St. Maries River, Kootenai Co., Aug. 10, 1894, *Henderson 2791* (G TYPE, R, US).

This species is dedicated to Mr. John Thomas Howell, of the California Academy of Sciences, who has been of the most invaluable service in procuring seed of *Grindelia*, and in carrying on detailed field work in California. Without his intense interest and coöperation the writer's knowledge of the genus would have been far more imperfect and very incomplete.

37. **G. integrifolia** DC. Prodr. **5**: 315. 1836; Torr. & Gray, Fl. N. Am. **2**: 248. 1842, mostly as to name only, but excluding synonymy and plants of *Scouler, Douglas,* and *Nuttall;* Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876, mostly as to name only; Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, in major part as to description and as to plants of *Howell, Hall,* and *Gray,* but excluding synonymy except *Donia inuloides* var. Hook.; Howell, Fl. N. W. Coast. 295. 1900, excluding range in British Columbia; Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906, mostly as to name and description, excluding synonymy and plants of *Piper 3805* and *Tolmie;* Henry, Fl. S. Brit. Col. 291. 1915, mostly as to name only, but excluding synonymy; Piper & Beattie, Fl. N. W. Coast. 362. 1915.

*G. villosa* Dougl. ex Sweet, Hort. Brit. ed. 2. 299. 1830, and ed. 3. 346. 1839, as nomen subnudum.

*Donia villosa* Hort. ex Hook. Comp. Bot. Mag. **2**: 141. 1836, as nomen nudum; Douglas, Jour. 328. 1914, as nomen nudum.

*Donia inuloides* β Hook. Fl. Bor. Am. **2**: 25. [1834] 1840.

Stems erect, stout, angled, strongly grooved, mostly fastigiately branched above with strongly ascending foliose branchlets bearing few to numerous heads, stramineous or pale buff, glandular-villous, the glandularity especially prominent towards heads, the lower half becoming glabrate, 5–7 dm. tall; leaves membranaceous, mostly pale green, scarcely resinous-punctate, upper and middle cauline entire or sparsely denticulate, 2–8 cm. long, 0.7–3 cm. broad, 2–4 times longer than broad, broadly ovate-lanceolate, acute to acuminate, strongly amplexicaul to subcordate, those on the floriferous branchlets enlarged beneath the heads, sparsely glandular-puberulent; disk 0.8–1.2 cm. high, mostly 1–2.7 cm. broad; involucre slightly to moderately resinous, bracts linear- to lanceolate-subulate, 5–12 mm. long, the outer and middle with the upper half to two-thirds free and loosely spreading, involute or arched-spreading or ascending with filiform-subulate tips, mostly glandular-puberulent; rays 16–28, the lamina 8–11 mm. long; achenes oblong, 3–4 mm. long, 1.5–2.3 mm. broad, faintly striate on angles and faces, mostly subtruncate at apex; awns mostly 2–3 to the floret, slender, tapering to a long slender aristate apex, entire to remotely serrulate, 3–4 mm. long, ½–⅔ length of disk-floret.

Distribution: dry slopes, fields, and open places in the Willamette River Valley region, Oregon, from the vicinity of North Yamhill, Yamhill Co., south to vicinity of Albany, Corvallis, and Douglas.

OREGON: "Ex America bor. Occid. Hort. Soc. London, Aug., 1830, Alph. DC." (CAL fragment of TYPE, CAL, G, photographs of TYPE); 1840, *Basil* (US); Jardin des Plantes, 1835, *Herb. J. Gay* (G); wet places, Washington Co., Aug., 1880, *T. Howell* (G, US); North Yamhill, July 8, 1882, *T. Howell* (PA, NY); "e sem." Oregon, Botanic Garden of Harvard Univ., 1873, *E. Hall* (G, US); 1860, *Bipontinus* (G); Corvallis, alt. 400 ft., June 27, 1916, *Gilbert 132* (O, US); Albany, June, *Lemmon* (CAL); Willamette Heights, Portland, June 22, 1902, *Sheldon S. 10665* (F, G, NY, PO, US); 1871, *E. Hall 264* (F, M, NY); dry slopes and pastures, Hood River, July 30, 1884, *Henderson 432* in part (M); Corvallis, alt. 235 ft., July 19, 1920, *Gilkey 79* (O); roadside banks, open fields, Pacific Highway, near Douglas, Lane Co. boundary, alt. 750 ft., June 10, 1926, *Ingram 2083* (O); bar along Willamette River, Salem, *J. C. Nelson 4512* (WI); 5 mi. n. of Corvallis, June 27, 1916, *Gilbert 474* (O); Corvallis, July 29, 1926, *Scullen* (O).

**37a. f. dentata** Steyermark, f. nov.[50]

Stems glabrous to sparsely villous above, mostly non-glandular; upper and middle cauline leaves coarsely dentate, those on floriferous branchlets dentate to subentire, membranaceous to firmly membranaceous or subcoriaceous; involucral bracts with filiform-subulate spreading or ascending tips.

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[50] **G. integrifolia f. dentata** Steyermark, f. nov., caulibus glabris vel supra parce villosis, plerumque non glandulosis; foliis caulinis superioribus et mediis grosse dentatis.—Collected on waste ground, Salem, Oregon, July 14, 1917, *J. C. Nelson 1670* (Gray Herb. TYPE).

Distribution: gravelly stream beds along railroads and waste ground in the vicinity of Salem, Albany, and Eugene, Oregon.

OREGON: along railroad, Salem, July 30, 1917, *J. C. Nelson 1796* (G); gravelly stream bed on S. 12th St., Salem, June 24, 1921, *J. C. Nelson 3912* (G, PA); waste ground, Salem, July 14, 1917, *J. C. Nelson 1670* (G TYPE); Albany, Linn Co., July 11, 1894, *Lloyd* (NY); dry ground south of Salem, Marion Co., July 19, 1928, *Thompson 5103* (M); moist ground, Salem, July, 1911, *Peck 4918* (WI).

**37b.** var. **virgata** (Nutt.) Torr. & Gray, Fl. N. Am. **2**: 248. 1842.

*G. virgata* Nutt. Trans. Am. Phil. Soc. N. S. **7**: 314. 1841; Torr. & Gray, Fl. N. Am. **2**: 248. 1842, as synonym; Walp. Rep. Bot. Syst. **2**: 585. 1843; Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, as synonym; Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906, as synonym.

*G. integrifolia* DC. acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, in part; acc. to Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906.

*G. nana* Nutt. acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 119. 1884, and ed. 2. 119. 1888, in part; acc. to Howell, Fl. N. W. Am. 296. 1900, in part; acc. to Piper & Beattie, Fl. N. W. Coast. 362. 1915, in major part.

Stems slender, dull reddish-brown or purplish-red to stramineous, glabrous to minutely glandular-puberulent, mostly 5.5–10.5 dm. tall; upper leaves entire to denticulate, middle and upper leaves 1.5–7 cm. long, 0.25–1.5 cm. broad, 5–10 times longer than broad, the upper linear-oblong or lanceolate-linear, acute to acuminate, subamplexicaul, the middle linear-oblanceolate to oblong-oblanceolate and subamplexicaul, acute, glabrous to sparsely glandular-puberulent; disk 0.8–1.2 cm. high, 0.9–1.7 cm. broad; involucre slightly to conspicuously resinous, glabrous to minutely glandular.

Distribution: fields and rocky slopes, local in vicinity of Vancouver, also on San Juan Islands, Washington, and south in the Willamette River Valley to Douglas Co., Oregon.

WASHINGTON: Vancouver, Sept., 1902, *Piper 3805* (US); F. V. (probably Fort Vancouver), *Tolmie* (G); dry rocky slope, 3½ miles from Friday Harbor, San Juan Islands, July 7, 1923, *Peck 12920* (ST).

OREGON: Eugene City, Sept. 1, 1889, *Greene* (N, NY); Salem, July 22, 1920, *Clemens* (CAS); Salem, *Johnson 518* (G, UW); Oregon, *Hooker* (G); North Yamhill, July 8, 1882, *T. Howell* (F, M, NY); rocky islands of the Willamette, and fields, Yamhill Co., also near Portland, July 8, 1882, and Sept. 12, 1888, *Henderson 434* in part (M, NY, O); gravelly plains, Salem, July, 1887, *Gorman* (UW); Columbia woods, *Nuttall* (PA isotype, PO photograph of isotype, B photograph of TYPE); Willamette River above Portland, July, 1878, *T. Howell* (US); Multnomah Co., June, 1877, *T. Howell* (US); abundant in dry ditches along road, Sutherlin, Douglas Co., Aug. 31, 1927, *Blake 10385* (B); Albany, July 20, 1924, *H. M. Hall 11996* (ST); Sutherlin, Douglas Co., June 19, 1916, *Peck 4916* (WI); damp open ground, Salem, June 14, 1909, *Peck 4904* (WI); dry soil by roadside, 1 mi. n. of Salem, Aug. 12, 1922, *J. C. Nelson 4618* (O).

### 37c. var. **virgata** f. **villosa** Steyermark, f. nov.[51]

Stems more or less villous with crooked weak hairs, more densely villous towards heads; leaves sparsely villous-puberulent on margins and puberulent on surfaces, somewhat resinous-punctate.

Distribution: Willamette Valley, Oregon.

OREGON: 1871, *E. Hall 266* (F, G, M TYPE, NY, US); fields in fir woods, Yamhill Co., July 8, 1882, *Henderson 432* in part (O).

This species has been confused with *G. stricta*, *G. oregana*, and *G. virgata* (*G. integrifolia* var. *virgata*), many botanists having interpreted it as the coastal plant of Washington, Oregon, and British Columbia. It is, however, an inland species, strictly limited to the Willamette Valley of Oregon. I have before me a photograph and fragment of the type of *G. integrifolia* DC. which is beautifully matched by villous-stemmed material collected in the Willamette Valley. De Candolle described his plant from a specimen cultivated at the Horticultural Society of London, seeds of which had been sent from western North America, undoubtedly collected and sent over by Douglas. On page 214 of Douglas's 'Journal' we read, "Picked up a species of *Donia* in flower and seed and a small annual plant closely allied to *Phlox*, both on rich light dry loam in open woods." At this time Douglas was encamped in an oak-pine belt on the south side of the Yamhill River, Oregon, and the night previously he had camped on the Multnomah River. The collection cited by Hooker "near the sources of the Multnomah River," under *Donia inuloides* β in 'Flora Boreali Americana' 2: 25. 1834, is probably the one which Douglas had made at the localities cited in his journal, and is *G. integrifolia.* In Sweet's 'Hortus Brittanicus' ed. 2. p. 299. 1830, and again in ed. 3. p. 346. 1839, there appears in the list of plants cultivated a *Grindelia* named "*G*[*rindelia*] *villosa* Dougl."; opposite the botanical names are the English names, apparently translations, since "villous" appears to the right of *Grindelia villosa* Dougl. This is undoubtedly the *Donia* which was referred to as *Donia villosa* Hort. ex Hook. 'Comp. Bot. Mag.' 2: 141. 1836, and which Douglas on p. 214 of his journal referred to as *Donia.* A specimen of *G. integrifolia* in the Gray Herbarium cited as such in the 'Synoptical Flora of North America' is labelled "Grindelia villosa" from J. Gay's herbarium, and is a plant which was cultivated at the Jardin des Plantes in 1835, according to data on this label; this specimen is typical *G. integrifolia* and probably represents plants cultivated from seeds of the same collection as De Candolle's type specimen.

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[51] **Grindelia integrifolia** var. **virgata** f. **villosa** Steyermark, f. nov., caulibus villosiusculis; foliis ad margines parce villoso-puberulis aliter puberulis.—Collected in Oregon, 1871, *E. Hall 266* (Mo. Bot. Gard. Herb. no. 130132 TYPE, F, G, NY, US, isotypes).

While Douglas's name, *G. villosa* Dougl. ex. Sweet, antedates *G. integrifolia,* and though there is no doubt that the seeds collected by Douglas from the Multnomah River region and grown in Europe and England represent the plant which De Candolle described as *G. integrifolia,* yet *G. villosa* Dougl. ex. Sweet remains as a *nomen nudum.* Although it may be contended that the English word "villous" was used after *G. villosa* in Sweet's 'Hort. Brit.' ed. 2 and 3, and that this adjective was sufficiently expressive to characterize and identify the species now passing as *G. integrifolia,* the fact remains that this use of the term "villous" was not a description, but only an English translation of the Latin. A similar case is Muhlenberg's 'Catalogue' where specific epithets are likewise translated, and since Muhlenberg's names are now universally regarded as *nomina nuda* or *subnuda,* the same must hold for the translatory use of names in Sweet's 'Hortus Brittanicus.'

Through an examination of many specimens from the Willamette Valley region such a considerable amount of intergradation has been found between *G. integrifolia* and *G. virgata* that the latter cannot be accepted as a distinct species, but must be regarded, instead, as a variety.

*Grindelia integrifolia* var. *virgata* and f. *dentata* have been confused with *G. nana* and varieties. The position of the involucral bracts is quite distinctive, however, for in *G. nana* and varieties the tips of the bracts are strongly recurved or revolute, whereas in *G. integrifolia* and varieties they are erect, ascending, or spreading-ascending.

38. **G. columbiana** (Piper) Rydb. in Bull. Torr. Bot. Club **37**: 128. 1910, without description; Fl. Rocky Mts. 849. 1917.

*G. discoidea* Nutt. Trans. Am. Phil. Soc. N. S. **7**: 315. 1841, not *G. discoidea* Hook. & Arn.; Walp. Rep. Bot. Syst. **2**: 586. 1843; Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876; Howell, Fl. N. W. Am. 296. 1900.

*G. nana* Nutt. var. *discoidea* (Nutt.) Gray, Syn. Fl. N. Am. **1**$^{2}$: 119. 1884, and ed. 2. 119. 1888; Henry, Fl. S. Brit. Col. 291. 1915, as to name only.

*G. nana columbiana* Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 556. 1906, as nom. nov. without description; Piper & Beattie, Fl. N. W. Coast. 362. 1915.

Stems fastigiately or corymbosely branched above, the slender floriferous branchlets strongly ascending and usually elongated, stramineous to purplish-red, glabrous, 2.5–8 dm. tall; leaves firmly membranaceous, dull olive- or pale-green, abundantly and conspicuously punctate, entire to remotely but regularly denticulate with short projections or coarsely or incised-dentate, main middle and upper cauline 2.5–10 cm. long, 0.3–1.5 cm. broad, 5–11 times longer than broad, lower and middle linear-oblong to broadly oblanceolate, upper oblong to lanceolate, acute, glabrous; heads discoid; disk mostly depressed-hemispherical, the receptacle slightly distending at the base, 0.7–1.1 cm. high, 0.9–2.0 cm. broad; involucre conspicuously and abundantly resinous, bracts 2–9 mm. long, terete and thickened, the outer and middle linear to narrowly lanceolate with subulate tips 1–2.5 mm. long, the upper third to fifth of the bracts strongly reflexed or revolute, glabrous; receptacle conspicuously foveolate; achenes narrowly oblong, 3.5–5 mm. long, 1.5–1.7 mm. broad, smooth or somewhat roughened on the striations, light brown or stramineous, when mature with usually 2 rather conspicuous knobs or projections or auriculately crowned at the apex; awns 2–3, slender, serrulate or setulose-serrulate, about ¾–⅞ length of disk-floret.

Distribution: gravelly or sandy banks, shores, bluffs, or river bars usually following river courses, occasionally on sage-brush plains and along railroad tracks and roadsides, from the mouth of the Columbia River along its course in Oregon and Washington and along the Snake River in Idaho.

IDAHO: Blackfoot, Aug. 9, 1892, *Mulford* (GM, MU, NY); dried sink, near Blackfoot, July 23, 1897, *Henderson 2996* (G).

WASHINGTON: sagebrush plains near Wilbur, Lincoln Co., June 30, 1931, *Thompson 7164* (B, CAL, E, G, M); along railroad tracks west of Western Storage Co., near Columbia River, Wenatchee, Chelan Co., alt. 365 m., Aug. 13, 1931, *Moore & Steyermark 3692* (M); 4 mi. east of Cle Elum, Kittitas Co., alt. 1000 m., Aug. 13, 1931, *Moore & Steyermark 3694* (M); sandy banks of the Columbia River, W. Klickitat Co., Sept., 1883, *Suksdorf 189* (CAL, F, G, US); Grand Coulee, above Blue Lake, Grant Co., July 5, 1926, *Babcock & Collins 52* (CAL); Kennewick, Benton Co., Aug., 1926, *G. N. Jones 354* (PA); Meyers Falls, Aug. 21, 1902, *Kreager 473* (G, MU, NY, US); Wilson Creek, Whitman Co., Aug. 6, 1892, *Lake & Hull 753* in part (UW); sandy banks of Columbia River, Bingen, W. Klickitat Co., Aug. 27, 1903, *Suksdorf 515* (ST).

OREGON: Dalles, June 10, 1868–9, *Kellogg & Harford 406* (G, US); slopes overlooking the Columbia River at the Dalles, Wasco Co., July 4, 1931, *J. T. Howell 7194* (CAS); Dalles, June 10, 1869, *Harford & Dunn* (NY); 1871, *E. Hall 268* (F, G); muddy shore of Columbia River on Hayden Island, opposite Vancouver, Washington, Oct. 9, 1920, *J. C. Nelson 3394* (G); Oregon plains, *Nuttall* (G); Vancouver, *Nuttall* (PA isotype of *G. discoidea* Nutt.); dry rocky bluffs, Shell Rock, Columbia River, Aug. 21, 1882, *Henderson 435* (M, O); Lower Albina, Portland, Aug. 12, 1902, *Sheldon s. 10960* (F, G, M, MU, NY, PO, US).

From *G. nana* this species differs chiefly in its more serrulate or setulose-serrulate pappus awns, discoid heads, and in a receptacle which becomes slightly distended at the base.

**39. G. stricta** DC. Prodr. **7**: 278. 1838; Torr. & Gray, Fl. N. Am. **2**: 248. 1842; Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876, as synonym; Macoun, Cat. Can. Pl. pt. 2. 209. 1884; Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, as synonym of *G. integrifolia;* Henry, Fl. S. Brit. Col. 291. 1915; Piper & Beattie, Fl. N. W. Coast. 363. 1915, as probable synonym.

*Donia glutinosa* Hook. Fl. Bor. Am. **2**: 25. [1834] 1840, in part, as to plant of *Scouler* in N. Y. Bot. Gard. Herb., and excluding synonymy, not *Donia glutinosa* R. Br.; Macoun, Cat. Can. Pl. pt. 2. 209. 1884, as synonym.

*G. hirsutula* Hook. & Arn. acc. to Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876, as to *Wilkes* plant in N. Y. Bot. Gard. Herb.

*G. integrifolia* DC. acc. to Torr. & Gray, Fl. N. Am. **2**: 248. 1842, as to plant of *Scouler;* Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, in large part, excluding range in British Columbia and synonymy as to *G. stricta* and *G. virgata;* Macoun, Cat. Can. Pl. pt. 2. 209. 1884, excluding plant of *Macoun;* Henry, Fl. S. Brit. Col. 291. (a). 1915, excluding *G. macrophylla.*

*G. oregana* Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, in small part, at least as to plant of *Hall 265;* Howell, Fl. N. W. Am. 296. 1900, in part, excluding habitat and range in Idaho; Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906, in large part, as to plants of *Conard 387* and *Lamb 1270;* Piper & Beattie, Fl. N. W. Coast. 363. 1915.

*G. oregana* Gray subsp. *Wilkesiana* Piper in Piper & Beattie, Fl. N. W. Coast. 363. 1915, as to plant of *Osgood.*

*G. oregana* Gray f. *Wilkesiana* (Piper) St. John & R. Sprague in Proc. Biol. Soc. Wash. **41**: 199. 1928.

Herbaceous to suffrutescent perennial, mostly with basal tufts of leaves; stems erect or ascending, usually decumbent at the base, slender, stramineous or greenish to rose-purple, unbranched to sparsely branched above with few or several slender floriferous branchlets bearing one or few heads, glabrous to loosely villous below the heads, 2–6 dm. tall; leaves rather few, scattered, fleshy, pale green, resinous-punctate, entire to denticulate or serrulate, the main cauline 5–13 cm. long, 0.7–2 cm. broad, 5–8 times longer than broad, narrowly oblanceolate to oblong-spatulate, acute to obtuse, narrowed below the middle to a slender subamplexicaul base, the upper leaves oblong to lanceolate-oblong, acute to obtuse, scarcely narrowed below the middle; disk depressed to campanulate-hemispherical, 1.1–1.5 cm. high, 1.6–2.5 cm. broad; involucre moderately or slightly resinous, 4–5-seriate, bracts linear to lanceolate with long subulate tips, 5–12.5 mm. long, rather thin and submembranaceous, the upper third to half of the bracts free and spreading, reflexed to incurved at the tips, glabrous to lightly villosulous; rays 22–35, conspicuously elongated, bright yellow to orange-yellow, the lamina 14–19 mm. long; achenes oblong, 3.5–5 mm. long, 1.5–2 mm. broad, stramineous to light brown, smooth or slightly roughened at the angles, the truncate or oblique apex slightly bordered at the angles with shallow low processes; awns 2–5 to the floret, remotely to numerously setulose-serrulate, 3–5.5 mm. long, mostly ½–¾ length of disk-floret.

Distribution: along the Pacific Coast in wet meadows and swampy coastal ground, sands, among driftwood, lagoons at the mouths of rivers by the coast and salt marshes along sloughs and canals, Port Mulgrave and Kasaan, southern Alaska, Queen Charlotte Islands, western coast of Vancouver Island, south to Mendocino Co., California.

WASHINGTON: on sands among "driftwood," Toke Point, Pacific Co., July 27, 1908, *Foster 831* (US); tufts along shore, Port Discovery, Jefferson Co., Sept. 13, 1921, *St. John 5860* (B); Oyhut, Chehalis Co., July 8, 1891, *Lamb 1270* (F, M, NY); wet meadows beside stream, Copalis, June and July 23, 1902, *Conard 387* (G, MU, NY); shores of Puget Sound near Steilacoom, Pierce Co., Aug. 22, 1933, *Thompson 9959* (M).

OREGON: Waldport, Lincoln Co., July 25, 1924, *Peck 13503* (B, WI); salt marsh north of Coos Bay, Coos Co., July 18, 1929, *Henderson 11420* (CAL); salt marshes, Tillamook Bay, July 15, 1882, *T. Howell* (F, NY); on shores of lagoon at mouth of Siuslaw River, Sept. 7, 1911, *Gorman X* (PA); North Bend, 5 mi. north, along highway, border of marsh, July 18, 1926, *Scullen 113* (O); salt marsh, bridge north of Coos Bay, Coos Co., July 18, 1929, *Henderson 11420* (UO); tidewater bog near Hauser, Coos Co., Aug. 22, 1929, *Henderson 11454* (UO); Marshfield, July, 1917, *Eschen* (WI); salt flat near Garibaldi, Tillamook Co., July 8, 1924, *Peck 13359* (WI).

CALIFORNIA: Crescent City, Del Norte Co., June 30, 1899, *Davy & Blasdale 5957* (CAL); sea bluffs beyond Westport, Mendocino Co., June, 1927, *Sutliffe* (CAS); Big Lagoon, Humboldt Co., Aug. 30, 1925, *Tracy 7255* (CAL); Big Lagoon, Humboldt Co., Aug. 22, 1927, *Wolf 783* (ST); Big Lagoon, June 25, 1926, *Kildale 2172* (ST); dry bluff, Dyerville, July 10, 1925, *Kildale 944* (ST).

ALASKA: Kasaan Mountain, July 16, 1902, *Newcombe* (US); *Haenke* (CAL fragment and photograph of TYPE, G, US photograph of TYPE).

CANADA: BRITISH COLUMBIA—sand spit, Crescent, Sept. 1, 1914, *Henry* (CAS); on the beach, Long Arm, Skidigate, Queen Charlotte Islands, July 26, 1897, *Newcombe* (CAN); Nootka Sound, *Scouler* (NY); Alberni, July, 1916, *Carter* (G); salt marsh near Alberni, Vancouver Island, June 27, 1916, *Henry 9049* (G).

**39a. f. venulosa** (Jepson) Steyermark, comb. nov.

*G. venulosa* Jepson, Man. Fl. Pl. Cal. 1021. 1925.

*G. glutinosa* (Cav.) Dunal acc. to Gray, Syn. Fl. N. Am. $1^2$:

119. 1884, and ed 2. 119. 1888, as to plant of *Bolander 6493* only.

*G. oregana* Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as to plant of *Hall* "cult. e. sem. Yaquina Bay, Oregon."

Stems erect or ascending, glabrous or infrequently villous; main cauline leaves sparsely to rather regularly dentate, especially in upper half, with short broad acute teeth, 4.5–9 cm. long, 1.5–3 cm. broad, 2½–4 times longer than broad, obovate-oblong, obtuse, gradually narrowed to a subamplexicaul base.

Distribution: sands along seashore and coastal lagoons, Tillamook and Lincoln Counties, Oregon south to Humboldt Co., California, and locally south to Marin Co., California.

OREGON: Garibaldi, Tillamook Co., Aug. 25, 1894, *Lloyd* (NY); "cult. e. sem.," Yaquina Bay, *Hall* (G, M, US).

CALIFORNIA: in quicksand on sea-shore near Big Flat, Humboldt Co., 1867, *Bolander 6493* (J TYPE, US); Shelter Cove, Humboldt Co., June 25, 1927, *Kildale 3554* (ST); Point Reyes, Marin Co., July, 1903, *Elmer 4621* (CAL, M, MU, NY, US).

**39b.** var. **procumbens** Steyermark, var. nov.[52]

Stems procumbent, subcaespitose 1.5–3.5 dm. tall; radical leaves shorter than the species, 4.5–9 cm. long.

Distribution: sandy seashores along coast, Humboldt Co., California.

CALIFORNIA: sandy shores, Big Lagoon, Humboldt Co., alt. 20 ft., July 10, 1921, *Tracy 5856* (PO); north shore of Big Lagoon, Humboldt Co., Sept. 14, 1930, *H. E. & S. T. Parks 0773* (CAL); on sandy seashore at base of cliffs, 10 miles north of Trinidad, Humboldt Co., alt. 1 m., Aug. 9, 1931, *Moore & Steyermark 3687* as to second sheet (M TYPE).

**39c.** var. **Andersonii** (Piper) Steyermark, comb. nov.

*G. Andersonii* Piper in Proc. Biol. Soc. Wash. **31**: 77. 1918.

Stems loosely villous near the heads; leaves numerous, crowded and conspicuously elongated on the floriferous branchlets immediately beneath the heads, the middle and upper cauline 5.5–9 cm. long, 4–7 mm. broad, mostly 10–15 times longer than broad, linear- to narrowly oblanceolate-spatulate, acute, narrowed to a subamplexicaul base.

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[52] **G. stricta** var. **procumbens** Steyermark, var. nov., caulibus procumbentibus, subcaespitosis, 1.5–3.5 dm. altis; foliis radicalibus brevioribus quam apud speciem, 4.5–9 cm. longis.—Collected on sandy seashore at base of cliffs, 10 miles north of Trinidad, Humboldt Co., California, alt. 1 m., Aug. 9, 1931, *Moore & Steyermark 3687* second sheet (Mo. Bot. Gard. Herb. no. 1025979 TYPE).

Distribution: tidal flats at Saanich Arm, Vancouver Island, British Columbia.

BRITISH COLUMBIA: Saanich Arm, Vancouver Island, July 5, 1917, *Anderson* (US photograph and fragment of TYPE).

**39d.** var. **aestuarina** Steyermark, var. nov.[53]

*G. hirsutula* Hook. & Arn. acc. to Gray, Syn. Fl. N. Am. 1²: 117. 1884, and ed. 2. 1²: 117. 1888, in part, as to plant of Lyall from Saturna Island.

*G. integrifolia* DC. acc. to Macoun, Cat. Can. Pl. pt. 3. 542. 1886.

*G. oregana* Gray acc. to Gray, Syn. Fl. N. Am. 1²: 118. 1884, and ed. 2. 118. 1888, in part, as to plant of *Douglas* in Gray Herb.; acc. to Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11:** 557. 1906, as to plants of *Binns*, and *Piper 2865*.

Stems glabrous, subcorymbosely to corymbosely branched above with several to many heads; leaves more firmly membranaceous, more conspicuously resinous-punctate, the main cauline subentire to remotely to moderately denticulate or serrulate with short acute teeth, sometimes only the apical region toothed, or sharply and closely serrate or dentate; involucre more conspicuously and abundantly resinous.

Distribution: salt marshes, sand spits, and beaches in the Puget Sound region, Washington, and north on the east coast of Vancouver Island, British Columbia.

UNITED STATES: WASHINGTON—tide-lands, Marysville, June, 1928, *Grant* (R TYPE); Vashon Island, Puget Sound, Sept. 12, 1909, *Moyer* (MU); Seattle, July, 1915, *Freiberg* (M); along beach, Port Ludlow, Sept. 5, 1890, *Binns* (G); salt marsh near West Point Lighthouse, Seattle, Oct. 11, 1911, *Havens* (UW).

CANADA: BRITISH COLUMBIA—Saturna Island, 1858, *Lyall* (G); sand spit at mouth of Campbell River, Vancouver Island, *J. T. Howell 7579* (CAS).

**39e.** var. **aestuarina** f. **elongata** Steyermark, f. nov.[54]

Stems glabrous, 5–9 dm. tall, much-branched above with elongated closely ascending foliose floriferous branchlets 1–

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[53] **G. stricta** var. **aestuarina** Steyermark, var. nov., caulibus erectis vel adscendentibus, irregulariter subcorymboso- vel corymboso-ramosis; foliis firme membranaceis, valde resinosis, caulinis principalibus subintegris vel remote vel moderatim denticulatis vel serrulatis cum dentibus brevibus tenuibus acutis vel salienter serratis vel dentatis; involucro valde et abundanter resinoso.—Collected in tide-lands, Marysville, Washington, June, 1928, *J. M. Grant* (Rocky Mountain Herb. TYPE).

[54] **G. stricta** var. **aestuarina** f. **elongata** Steyermark, f. nov., caulibus glabris, 5–9 dm. altis, supra valde ramosis, ramusculis floriferis elongatis saepius adscendentibus; foliis firme membranaceis vel subcoriaceis, caulinis superioribus et illis in ramusculis floriferis remote denticulatis cum dentibus brevibus tenuibus

3 dm. long, bearing several to many heads; leaves firmly membranaceous, remotely to closely serrate or denticulate with short fine teeth, or more saliently serrate or dentate sometimes only about the base, the upper cauline and those on floriferous branchlets lanceolate to ovate-lanceolate, acute to acuminate, subamplexicaul to amplexicaul, glabrous except for the sparsely scabridulous margins; disk 0.9–1.5 cm. high, 1.6–2.5 cm. broad; involucre moderately resinous, outermost bracts merging gradually into the more reduced leaves immediately surrounding the heads, linear to lanceolate with conspicuously elongated attenuate subulate tips 7–16 mm. long, glabrate to pilosulous.

Distribution: along estuaries and tidal ground, vicinity of Victoria, Vancouver Island, British Columbia, and near Seattle, Washington.

UNITED STATES: WASHINGTON—East Sound, San Juan Islands, June 25–Aug. 1, 1917, *S. M. & E. B. Zeller 955* (G, M, MU, NY).

CANADA: BRITISH COLUMBIA—margin of arm of Victoria Harbor, 3 miles from Victoria on Island Highway, Vancouver Island, July 27, 1931, *J. T. Howell 7545* (CAS TYPE, M isotype).

**39f.** var. **macrophylla** (Greene) Steyermark, comb. nov.

*G. macrophylla* Greene, Pitt. **3**: 297. 1898; Henry, Fl. S. Brit. Col. 291. 1915, as synonym.

*G. integrifolia* DC. acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, in part, as to plant of *Suckley* from Fort Steilacoom, Puget Sound; Henry, Fl. S. Brit. Col. 291. (a). 1915, in part.

*G. oregana* Gray acc. to Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906, in part, as to plant of *Suckley* from Fort Steilacoom.

Stems stout, glabrous below, lightly to densely villous or glandular-villous near the heads, strongly corymbosely branched above with stout elongated strongly ascending foliose floriferous branchlets 1–3 dm. long, bearing several to numerous heads, 0.5–1 m. tall; leaves thin and membranaceous, pale

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acutis vel acuminatis vel salientioribus basi modo vel serratis cum dentibus salientibus, lanceolatis vel ovato-lanceolatis; bracteis extremis involucri valde elongatis, foliaceis.—Collected on margin of arm of Victoria Harbor, 3 miles from Victoria on Island Highway, Vancouver Island, British Columbia, July 27, 1931, *J. T. Howell 7545* (Cal. Acad. Sci. Herb. no. 188502 TYPE, M, isotype).

green, scarcely resinous-punctate, entire to remotely coarsely dentate, the middle and upper cauline 2–11 cm. long, 0.5–2.5 cm. broad, broadly oblong-lanceolate or oblong to ovate-lanceolate or pandurate-oblong, acute, subamplexicaul to amplexicaul, the radical 2–4 dm. long, 1.5–4.5 cm. broad, glabrous; disk 1.2–1.6 cm. high, 1.9–3 cm. broad; involucre scarcely resinous, bracts 1–2 cm. long, the outer and middle loosely spreading or ascending with filiform-subulate or linear to linear-lanceolate tips 5–10 mm. long; rays 25–35, conspicuous, the lamina 15–20 mm. long; achenes 5–7.5 mm. long; awns mostly moderately to numerously setulose to serrulate.

Distribution: salt marshes along estuaries, Vancouver and vicinity, British Columbia, south locally in Puget Sound region, about Seattle and Steilacoom, Washington.

United States: washington—Point Orchard, July, 1889, *Piper* (UW); abundant in marine marshes, Seattle, July, 1892, *Piper* (G, NY, UW); Fort Steilacoom, Puget Sound, *Suckley* (G, NY, US).

Canada: british columbia—wet ground, salt marsh, Crescent, Sept. 10, 1914, *Henry* (NY); salt marsh, Vancouver, Oct. 9, 1914, *Henry* (CAS); tide-water swamp near Vancouver, July, 1890, *Greene* (N type).

39g. var. **Hendersoni** (Greene) Steyermark, comb. nov.

*G. Hendersoni* Greene, Pitt. **2**: 18. 1889; Howell, Fl. N. W. Am. 295. 1900; Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906; Piper & Beattie, Fl. N. W. Coast. 363. 1915, as synonym.

*G. integrifolia* DC. acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, in part, as to plant of *Lyall* from Fidalgo Island.

*G. oregana* Gray acc. to Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906, as to plant of *Lyall* from Fidalgo Island.

Suffrutescent perennial with tufts of leaves arising from branching ligneous stems, the herbaceous shoots of the season from branching aerial elongated ligneous stems up to 2.5 dm. long, the herbaceous shoots 2.5–3.6 dm. tall, loosely to densely villous or lanulose, mostly simple throughout and bearing one or few heads on unbranched or sparsely branched foliose branchlets; leaves entire to closely or rather remotely dentate or serrate with short broad teeth, the main cauline 5.5–7 cm. long, 1–1.5 cm. broad, the middle and upper cauline oblong, obtuse, submucronate, subamplexicaul, lightly hirsutulous or somewhat closely villosulous to glabrate; involucral bracts villosulous to glabrous, the outer more pubescent.

Distribution: rocky shores on Lummi and Fidalgo Island, Puget Sound, Washington, north to British Columbia.

UNITED STATES: WASHINGTON—Fidalgo Island, 1858, *Lyall* (G); rocky banks, Bellingham Bay and Gulf of Georgia, *Henderson 1676* in part (F, G, N TYPE); Whidby Island, July, 1896, *Gardner* (CAL).

CANADA: BRITISH COLUMBIA—Oak Bay, Vancouver Island, June 17, 1902, *Diehl 150* (PO); sand hills, Pt. Holmes, near Comox, July 1, 1893, *Macoun* (CAN).

39h. var. **lanata** (Greene) Steyermark, comb. nov.

*G. lanata* Greene, Pitt. **2**: 290. 1892; Henry, Fl. S. Brit. Col. 290. 1915.

*G. hirsutula* Hook. & Arn. acc. to Gray in Geol. Surv. Cal. Bot. **1**: 303. 1876, in part, as to plant of *Holmes* from Fraser River; acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, as to plant of *Holmes* from Fraser River.

*G. integrifolia* DC. acc. to Macoun, Cat. Can. Pl. pt. 2. 209. 1884, in part, as to plants of *Macoun*.

*G. oregana* Gray acc. to Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11**: 557. 1906, as to plant of *Henderson 2300* on left side of sheet.

*G. oregana* subsp. *Wilkesiana* Piper in Piper & Beattie, Fl. N. W. Coast. 363. 1915, in part, as to plants from Nisqually, *Wilkes Exped.*, and Fraser River, *Holmes*.

*G. integrifolia* DC. var. *aestivalis* Henry, Fl. S. Brit. Col. 291. 1915, in part.

Herbaceous stems of the season arising directly or almost directly from the main caudex, 4–7 dm. tall, corymbosely to subcorymbosely branched above with several rather elongated branchlets bearing several heads, lightly to densely villous or lanulose, especially in the upper portions; leaves entire to serrate, the middle and upper cauline (including those on floriferous branchlets) 1.5–9 cm. long, 0.5–3.5 cm. broad, oblong or oblong-oblanceolate to pandurate-oblong or ovate-lanceolate, subamplexicaul to amplexicaul, slightly to moderately villous or glabrate and villosulous only on margins; involucral bracts sparsely to densely villosulous or lanulose to glabrate, the outer bracts mostly pubescent.

Distribution: rocky or open places near seashore, or sometimes escaped along roadsides, near Vancouver, British Columbia, southern and eastern Vancouver Island and scattered in the Puget Sound region, Washington.

UNITED STATES: WASHINGTON—Gulf of Georgia, Lummi Island, 1888, *Henderson 1676* in part (G); roadside near station, Friday Harbor, San Juan Islands, July 27, 1923, *Peck 13138* (M); along shore, Oak Park, Victoria, June 23, 1920, *Eastwood 9727* (CAS); Nisqually, *Wilkes 22* (US).

CANADA: BRITISH COLUMBIA—Fraser River, *Holmes* (G, NY, US); on rocks by the sea, Oak Bay, Vancouver Island, June 18, 1887, *Macoun* (CAN, N TYPE); Kitsilano, Vancouver City, Aug. 21, 1911, *Malte* (CAN, US); Vancouver Island, June 18, 1902, *M. E. Jones* (PO); near shore, Oak Bay, Victoria, July 26, 1913, *Henry* (NY).

**39i.** var. **collina** (Henry) Steyermark, comb. nov.

*G. collina* Henry, Fl. S. Brit. Col. 291. 1915.

*G. oregana* Gray acc. to Piper in Contr. U. S. Nat. Herb. [Fl. Wash.] **11:** 557. 1906, as to plant of *Henderson 2300* on right side of sheet.

*G. integrifolia* DC. var. *aestivalis* Henry, Fl. S. Brit. Col. 291. 1915, in part.

*G. nana* var. *discoidea* (Nutt.) Gray acc. to Henry, Fl. S. Brit. Col. 291. 1915.

Stems slender, mostly corymbosely branched above with slender ascending floriferous branchlets bearing several heads, glabrous or villous below, sparsely to moderately villous above, 2.5–7 dm. tall; leaves firmly membranaceous, slightly to moderately resinous-punctate, the main cauline remotely denticulate or serrulate to sharply serrate, the upper cauline entire to subentire, the middle and upper cauline (including those on floriferous branchlets) 2–7 cm. long, 0.2–1.2 cm. broad, narrowly oblong-lanceolate or linear-oblong to oblanceolate-spatulate, glabrous to villosulous; disk 0.8–1 cm. high, 1.1–2 cm. broad; involucre moderately to rather abundantly resinous, the bracts with slender filiform to subulate tips 2–6 mm. long, mostly glabrate or sparsely villosulous; lamina of rays 10–14 mm. long; achenes 3–4 mm. long, 1.5–1.8 mm. broad.

Distribution: dry or rocky hillsides, about lakes slightly inland or sea-cliffs or rocky banks near sea-shore, southern Vancouver Island, and in the Puget Sound region, Washington.

UNITED STATES: WASHINGTON—Goose Rock, Coupeville, July, 1923, *Grant* (UW); dry bluffs, July, 1922, *Grant* (G); Friday Harbor, San Juan Islands, June 25–Aug. 1, 1917, *S. M. & E. B. Zeller 954* (G, M, MU, NY).

CANADA: BRITISH COLUMBIA—on a dry open hillside (inland), Thetis Lake, Vancouver Island, June 13, 1919, *Carter* (G); rocky hillside overlooking sea, Victoria, July 21, 1912, *Henry* (CAS); dry hill, Thetis Lake (near Victoria), Vancouver Island, July 18, 1915, *Henry* (NY TYPE).

The identity of this species has puzzled previous authors. A careful examination of a fragment and photograph of the type shows that this is the coastal species ranging from Alaska to California, which has passed, together with its varieties and forms, as *G. hirsutula* in part, *G. integrifolia* in part, *G. oregana* in part, and *G. glutinosa*. The locality where Haenke collected *G. stricta* was cited by De Candolle as Port Mulgrave, and although a number of Haenke's localities have been mixed in data or have proved obscure or erroneous, it is to be noted that in the case of *G. stricta* it is probably correct. Notwithstanding the fact that there are several "Port Mulgraves" and "Mulgraves" scattered throughout the world, there is a Port Mulgrave on Yakutat Bay, Alaska, in lat. 59° 34′ N. This was an Indian Village and Moravian Mission station, and Haenke's expedition undoubtedly stopped here since Yakutat

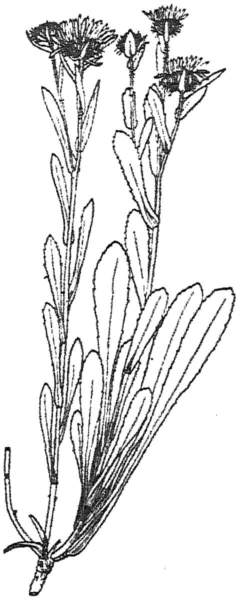

Fig. 32. *G. stricta.* × ⅕.

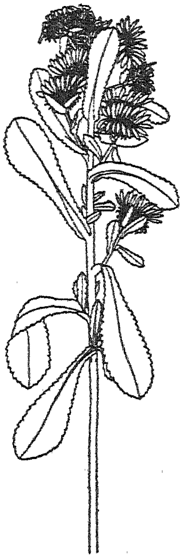

Fig. 33. *G. aggregata.* × ⅕.

Bay is a well-known port in Alaska. The evidence for the occurrence of *G. stricta* this far north along the Pacific coast is strengthened by the fact that I have before me a specimen of *G. stricta* from Alaska collected by Newcombe around the region of Kasaan Mountain in Alaska (deposited in the U. S. Nat. Herb.). Other collections from Queen Charlotte Islands and Nootka Sound, British Columbia, link the Alaska stations with those farther south.

This species is quite variable in leaf shape and size, and in pubescence, and the many entities described as species are best treated as varieties and forms under the historical species, *G. stricta.*

40. **G. aggregata** Steyermark, sp. nov.[55]

Stems stout, subracemosely branched with short ascending foliose contracted floriferous branchlets bearing agglomerate heads, or the whole forming a compactly arranged cluster, uniformly leafy throughout, buff or stramineous to rose-purplish, mostly glabrous, 4–6 dm. tall; leaves rather firm and fleshy or subcoriaceous, pale or dull green, scarcely resinous-punctate, closely and coarsely serrate or dentate, or sometimes the upper closely serrulate, the middle and upper cauline 4–10 cm. long, 1–3 cm. broad, 3–5 times longer than broad, the main cauline oblanceolate- to obovate-spatulate, mostly obtuse, narrowed to the base, glabrous except for sparsely villosulous margins; heads radiate, 3.5–4 cm. broad; disk campanulate-hemispherical, the sides slightly distending downward in fruit, 1–1.5 cm. high, 1.5–2.5 cm. broad; involucre moderately to abundantly resinous, 4–5-seriate, 0.9–1.3 cm. high, bracts lanceolate, the upper third to half free with short spreading or reflexed-squarrose subterete thickened tips 1–4 mm. long, glabrous; receptacle conspicuously foveolate; rays 23–33, bright yellow, lamina 9–13 mm. long; achenes oblong, light brown or tawny, smooth to slightly striated about the somewhat winged angles, 2.8–3.6 mm. long, 1.3–1.7 mm. broad, truncate to slightly 2–3-auriculate at apex; awns 2–4 to the floret, stout to slender, 2.5–4.2 mm. long, mostly ½–¾ length of disk-floret, remotely serrulate to numerously serrulate or setulose-serrulate.

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[55] **G. aggregata** Steyermark, sp. nov., perennis herbacea; caulibus glabris, plerumque subracemose ramosis, ramusculis floriferis brevibus adscendentibus et contractis, capitula agglomerata ferentibus, 4–6 dm. altis; foliis plus minusve firmis et carnosis vel subcoriaceis, pallide viridibus, parce resinoso-punctatis, contigue et grosse serratis vel dentatis, caulinis mediis et superioribus 4–10 cm. longis, 1–3 cm. latis, 3–5 plo longioribus quam latis, caulinis principalibus oblanceolato- vel obovato-spathulatis, plerumque obtusis, ad basem attenuatis; involucro moderatim vel abundanter resinoso, bracteis cum apicibus patentibus vel reflexo-squarrosis, parte libera subterete crassescente; aristis 2–4, 2.5–4.2 mm. longis, remote vel numerose serrulatis vel setuloso-serrulatis, plerumque disci flores in longitudine ½–¾ aequantibus.—Collected at sea-shore, Victoria, British Columbia, Canada, Aug. 27, 1902, *J. W. Congdon* (Mo. Bot. Gard., Herb. no. 130104 TYPE).

Distribution: salt marshes and tidal flats, vicinity of Victoria, Vancouver Island, British Columbia.

British Columbia: shore banks, Victoria, July 10, 1898, *Pineo* (CAL); rocks by the sea, Beacon Hill, Vancouver Island, July 4, 1887, *Macoun* (CAN, M), and Beacon Hill, Aug. 12, 1893, *Macoun* (CAN); Victoria, March 26, 1900, *Magnus* (G); Victoria, Sept. 7, 1909, *Moyer* (MU); Victoria, Aug. 23, 1908, *Nichols* (G); sea-shore, Victoria, Aug. 27, 1902, *Congdon* (M type); sea-shore, Victoria, Aug., 1923, *W. A. & C. B. Setchell* (CAL).

The arrangement of the short floriferous branchlets in a compact narrow inflorescence and the firm subcoriaceous or fleshy main cauline leaves, obovate to spatulate, mark this as an entity which must be segregated as a specific unit from the *G. stricta* group.

**41. G. Blakei** Steyermark, sp. nov.[56]

Suffruticose perennial with tufts of leaves on sterile or leafy shoots; stems slender, herbaceous flowering or leafy shoots of

[56] **G. Blakei** Steyermark, sp. nov., suffruticosa; caulibus herbaceis floriferis e axibus ligneis ramosis aeriis, glabris, 4.5–8 dm. altis; foliis firmis vel carnoso-coriaceis, atro viridibus, minime resinoso-punctatis, integris vel remote serrulatis vel crenulato-serratis, caulinis principalibus 4–6 cm. longis, 0.7–1.4 cm. latis, 4–7 plo longioribus quam latis, lineari-oblongis vel oblongis, illis in ramusculis floriferis adversum capitula paullum reductis; capitulis 4.5–5.5 cm. latis; disco 1.2–1.5 cm. alto, 1.4–2.5 cm. lato; involucro abundanter resinoso, bracteis parte superiore liberis et valde revolutis vel valde reflexis, lineari- vel lanceolato-subulatis cum apicibus longo-filiformibus vel subulatis, 3–6 mm. longis, teretibus, coriaceis; ligulis 24–45, elongatissimis, aureo-luteis, 13–25 mm. longis, 3.5–4.2 mm. latis; achaeniis oblongis, 5–7 mm. longis; aristis 2–6, robustis, 3.8–6 mm. longis, remote vel moderatim vel numerose serrulatis, disci flores in longitudine ⅔–¾ aequantibus.—Collected in salt meadows along canal, Eureka, Humboldt Co., California, alt. ½ m., Aug. 9, 1931, *J. A. Moore & J. A. Steyermark 3686* (Mo. Bot. Gard. Herb. no. 1025982 type).

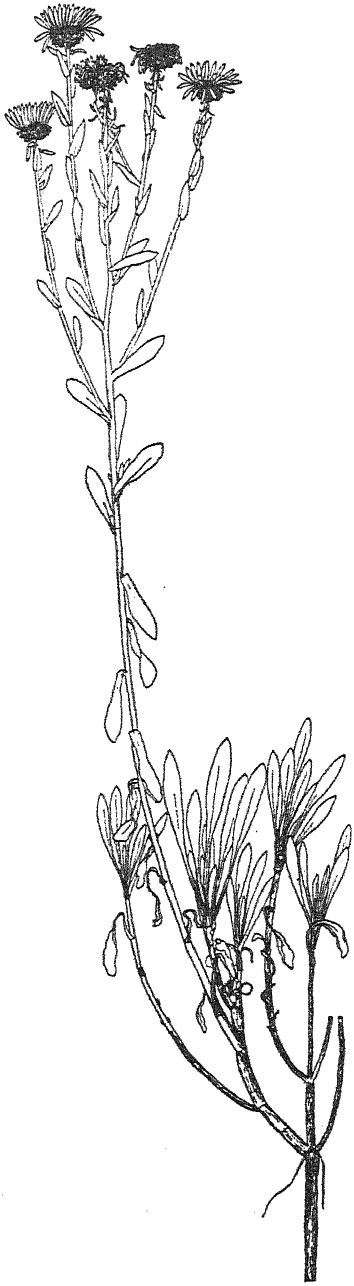

Fig. 34. *G. Blakei.* × ⅙.

the season arising from the branching aerial ligneous lower portion, corymbosely or subcorymbosely branched above the middle with few or several ascending branchlets bearing single terminal heads, chestnut- or purplish-brown, glabrous, 4.5–8 dm. tall; leaves firm or fleshy-coriaceous, dark olive-green, scarcely or apparently not at all resinous-punctate, entire to remotely serrulate or crenulate-serrate, the main cauline 4–6 cm. long, 0.7–1.4 cm. broad, 4–7 times longer than broad, linear-oblong to (the upper) oblong-lanceolate, obtuse to (the upper) acute, subamplexicaul or about as broad at base as at apex, glabrous; heads 4.5–5.5 cm. broad; disk campanulate-hemispherical, 1.2–1.5 cm. high, 1.4–2.5 cm. broad; involucre abundantly resinous, 5–6-seriate, bracts coriaceous, 5–12 mm. long, linear to lanceolate with long filiform or subulate terete and thickened tips 3–6 mm. long, glabrous, upper third to half free and strongly revolute or strongly reflexed; receptacle conspicuously foveolate; rays 24–25, conspicuously elongated, bright chrome-, cadmium-, or orange-yellow, the lamina 13–

25 mm. long, 3.5–4.2 mm. broad; achenes oblong, light chestnut-brown to buff, 5–7 mm. long, 1.6–2.3 mm. broad, striated or slightly grooved, slightly bordered at the apex with a shallow broad process, unequally developed, more prominent at one angle than at the other; awns 2–6 to the floret, stout, linear-lanceolate, 3.8–6 mm. long, remotely to moderately or numerously serrulate, ⅔–¾ length of disk-floret.

Distribution: salt marshes and salt-water sloughs about Humboldt Bay, Humboldt Co., California.

CALIFORNIA: common, brackish marsh, Eureka, Humboldt Co., Aug. 29, 1927, *Blake 10368* (B); common along salt-water sloughs near Samoa, Humboldt Co., alt. 0 to 500 ft., Sept. 19, 1909, *Tracy 3094* (CAL, G, US); occasional in a salt marsh at Eureka, Humboldt Co., July 21, 1924, *Heller 13870* (F, M, NY); Arcata, July 16, 1931, *M. E. Jones 29143* (CAL, M); Eureka, Sept. 26, 1921, *O'Con* (CAS); salt meadows along canal, Eureka, Humboldt Co., alt. ½ m., Aug. 9, 1931, *Moore & Steyermark 3686* (M TYPE); marshes along highway between Eureka and Arcata, Humboldt Co., Aug. 31, 1927, *Abrams 12057* (ST); salt marsh, Eureka Bay, on the road to Arcata, Humboldt Co., Aug. 28, 1927, *Wolf 1184* (ST).

This is an endemic of the salt and brackish marshes and sloughs of Humboldt Bay, northern California, and related to the *G. humilis* and the *G. stricta* group. From the former it differs in its much shorter ligneous axis which is usually less than 3.5 dm. tall, in its longer more strongly revolute involucral bracts, longer rays, broader leaves, and fewer and larger heads; from the latter, in its leathery-coriaceous leaves, strongly revolute involucral bracts, and longer rays.

This species is named for Dr. S. F. Blake, who collected it in 1927 and who has rendered much aid to the writer during the course of this monographic study.

**42. G. hirsutula** Hook. & Arn. Bot. Beechey Voy. 147. 1833; DC. Prodr. **7**: 278. 1838; Torr. & Gray, Fl. N. Am. **2**: 247. 1842, in large part, but excluding *G. rubricaulis* DC.; Gray in Geol. Surv. Cal. Bot. **1**: 303. 1876, in small part, excluding *G. rubricaulis* and excluding plants from Monterey and along the coast to Puget Sound; Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, in small part, excluding *G. rubricaulis* and plants from Monterey; Greene, Fl. Franc. pt. 4. 362. 1897, as to name only.

*G. rubricaulis* DC. acc. to Greene, Man. Bot. San Franc. Bay Reg. 171. 1894, as to name only; acc. to Jepson, Fl. W. Mid. Cal. 555. 1901, and ed. 2. 462. 1911, as to name only; acc. to Jepson, Man. Fl. Pl. Cal. 1020. 1925, as to name only.

Herbaceous perennial; stems slender, the floriferous branchlets few, simple or scarcely and remotely loosely branched with solitary terminal heads, mostly reddish- or purplish-brown to buff, villous- or crisp-pubescent, 2.7–4 dm. tall; leaves submembranaceous, dull olive-green, scarcely resinous-punctate, remotely serrate or denticulate to entire, the middle and lower cauline 1.6–8 cm. long, 0.4–1.5 cm. broad, 3–7 times longer than broad, those on the floriferous branchlets only gradually reduced near the heads, oblong or oblong-spatulate to (the upper) oblong-lanceolate, obtuse to acute, subamplexicaul to (the upper) amplexicaul, crisp- or villous-puberulent; heads 3.8–5.5 cm. broad; disk campanulate-hemispherical, 0.9–1.6 cm. high, 2–2.6 cm. broad; involucre resinous mostly about tips of bracts and on the innermost bracts, 4–5-seriate, the inner and middle bracts erect with mostly straight flattened tips, the outer and middle hirsutulous throughout; rays 25–40, bright yellow, the lamina 14–20 mm. long; stigmas oblong-lanceolate, moderately exserted; achenes oblong, 4–4.5 mm. long, about 2 mm. broad, dark or fulvous-brown, furrowed or ribbed, 2–3-toothed or bordered at apex with an undulate crown; awns 2–4 to the floret, 3.5–6.5 mm. long, ¾–⅞ length of disk-floret, entire to remotely serrulate.

Distribution: near the coast, Marin and San Mateo Counties, west-central California.

CALIFORNIA: Sausalito, Marin Co., June 9, 1912, *Eastwood 280* (CAS, G, M, NY, US); Sausalito, Marin Co., June, 1928, *Eastwood* (CAL, CAS); "California," *Beechey* (CAL fragment and photograph of TYPE, G, US photograph of TYPE); Sausalito Hills, Marin Co., July 23, 1933, *J. T. Howell 11454, 11455, 11456* (CAS, M); hills south of Vistacion Valley, San Francisco, July 9, 1933, *J. T. Howell 11436* (CAS, M); Sausalito Hills, Marin Co., April 12, 1933, *J. T. Howell 10996, 10997, 10998* (CAS, M).

**42a. f. patens** (Greene) Steyermark, comb. nov.

*G. patens* Greene, Pitt. **2**: 290. 1892; Man. Bot. San Franc. Bay Reg. 172. 1894; Fl. Franc. pt. 4. 362. 1897.

*G. robusta* var. *patens* (Greene) Jepson, Fl. W. Mid. Cal.

554. 1901, and ed. 2. 462. 1911, in major part and excluding plants from Santa Cruz Mountains west of Gilroy; Jepson, Man. Fl. Pl. Cal. 1020. 1925, in major part.

*G. robusta* var. *maritima* (Greene) Jepson, Fl. W. Mid. Cal. 554. 1901, and ed. 2. 461. 1911, excluding *G. rubricaulis* var. *maritima;* Jepson, Man. Fl. Pl. Cal. 1020. 1925, excluding *G. rubricaulis* var. *maritima.*

Stems lightly or not at all villous-pubescent below, becoming densely villous-pubescent towards the heads, simple or sparingly branched with elongated corymbose branches bearing solitary heads, 1.5–3 or more dm. tall, conspicuously foliose with more or less congested leaves; leaves subtending heads crowded and not reduced, crisp- or loosely villous-puberulent; disk 1.3–1.5 cm. high, 2–2.5 cm. broad; involucral bracts moderately to densely villous or lanate-pubescent, the outer becoming enlarged and foliaceous, usually equalling or surpassing the disk, erect to spreading or the outer and middle with slightly recurved tips, lanceolate or broadly- to ovate-lanceolate, acute; awns 2–6 to the floret, entire.

Distribution: Berkeley hills, Alameda Co., San Mateo, and Marin Counties, western-middle California.

CALIFORNIA: summit of Coast Range, San Mateo Co., May 10, 1902, *Baker 812* (G, M, NY, PO, US); near Saratoga, Santa Cruz Mts., alt. 700 ft., May 19, 1906, *Pendleton 351* (CAL); Crystal Springs Lake, San Mateo Co., May 1, 1902, *Baker 687* (PO); San Andreas Lake, San Mateo Co., April 8, 1903, *Baker* (PO); Crystal Springs, San Mateo Co., June 10, 1912, *Eastwood 322* (CAS, G, NY, US); redwoods, near San Francisco, 1866, *Kellogg* (CAL); Berkeley, 18—, *Klee* (CAL); Berkeley hills, May 31, 1896, *Jepson* (CAL); shallow soil overlying serpentine, Crystal Springs Lake, San Mateo Co., May 26, 1933, *J. T. Howell 11348* (CAS, M); Berkeley, July, 1881, *Greene* (F, N TYPE collection of *G. patens*); Olema, Marin Co., July 4, 1896, *Eastwood* (CAL COTYPE of *G. robusta* var. *maritima*); Pilarcitos Lake and Cañon, San Mateo Co., June 21–23, 1893, *Davy* (CAL COTYPE of *G. robusta* var. *maritima*).

**42b. f. cacumena** Steyermark, f. nov.[57]

Stems 2.5–3.8 dm. long, densely villous- to lanate-pubescent;

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[57] **G. hirsutula f. cacumena** Steyermark, f. nov., caulibus 2.5–3.8 dm. longis, dense villoso- vel lanato-pubescentibus; foliis congestis, lanatis vel dense villosis; bracteis involucri congestis, numerosis, 7–8-seriatis, anguste vel lineari-lanceolatis cum apicibus brevibus subulatis plerumque recurvatis vel reflexis, dense villosiusculis vel lanato-pubescentibus.—Collected on Oakland Hills, California, alt. 2000 ft., 1866, *Bolander 389* (U. S. Nat. Herb. TYPE, NY isotype).

leaves crowded, densely villous-pubescent, becoming wooly at the base; involucral bracts crowded, numerous, in 7–8 series, narrowly or linear-lanceolate with short subulate mostly recurved or reflexed tips, rather densely villous or lanate-pubescent.

Distribution: Oakland hills, west-central California.

CALIFORNIA: Oakland hills, alt. 2000 ft., 1866, *Bolander 389* (NY, US TYPE).

**42c.** var. **brevisquama** Steyermark, var. nov.[58]

*G. hirsutula* of most authors, at least in part, not Hook. & Arn.; acc. to Torr. & Gray, Fl. N. Am. **2**: 247. 1842, in part, and excluding *G. rubricaulis;* acc. to Gray in Geol. Surv. Cal. Bot. **1**: 303. 1876, in part, and excluding *G. rubricaulis* and plants from Monterey and along coast to Puget Sound; acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, in part, and excluding *G. rubricaulis.*

*G. rubricaulis* of most authors, at least in part, not DC.; acc. to Greene, Man. Bot. San Franc. Bay Reg. 171. 1894; acc. to Greene, Fl. Franc. pt. 4. 362. 1897; acc. to Jepson, Fl. W. Mid. Cal. 554. 1901, and ed. 2. 462. 1911, in large part; Man. Fl. Pl. Cal. 1020. 1925, in large part.

Stems crisp- or villous-pubescent, 3–8 dm. tall; leaves remotely to closely dentate or denticulate to entire, the radical and sometimes the lower cauline incised-dentate or pinnatifid, the middle and lower cauline 3–10 cm. long, 0.5–2 cm. broad, 4½–9 times longer than broad, linear-oblong to oblong-oblanceolate, mostly narrowed at base to subpetiolate, those on floriferous branchlets mostly reduced towards heads, especially the upper leaves crisp- or villous-puberulent on both surfaces; heads smaller than the species, 2.5–3.5 cm. broad; disk smaller, 0.8–1.1 cm. high, 1–2 cm. (sometimes 2.5 cm.) broad; involucre more conspicuously resinous, the bracts erect and appressed, the outer ones 3–7 mm. long, outer and middle slightly spreading or subsquarrose at the tips, broadly or ovate-lanceolate with acute to short subulate tips, glabrous to puberulent; rays mostly 10–15 mm. long.

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[58] **G. hirsutula** var. **brevisquama** Steyermark, var. nov., caulibus praesertim supra medium plus minusve laxe villoso-pubescentibus, 3–8 dm. altis; foliis remote vel contigue dentatis vel denticulatis vel integris, caulinis mediis et inferioribus 3–10 cm. longis, plerumque 0.5–2 cm. latis, 4½–9 plo longioribus quam latis, lineari-oblongis vel oblongo-oblanceolatis, plerumque ad basem attenuatis vel subpetiolatis, illis in ramusculis floriferis plerumque adversum capitula contractis, crispo- vel villoso-puberulis; disco minore quam apud speciem, 0.8–1.1 cm. alto, 1–2 cm. lato; bracteis involucri plerumque erectis et appressis (exterioribus et mediis paullum patentibus vel subsquarrosis), exterioribus non foliaceis, 3–7 mm. longis, late vel ovato-lanceolatis cum apicibus acutis vel breviter subulatis, glabris vel puberulis.—Collected in shallow clay soil of rocky hill, Black Point Road, Sonoma Co., California, July 13, 1930, *J. T. Howell 5338* (Cal. Acad. Sci. Herb. no. 187939 TYPE, CAL isotype).

Distribution: clay or rocky, grassy or semi-wooded slopes and hillsides, Napa, Marin, Sonoma, Contra Costa, and San Mateo Counties, west-central California, and locally south in San Luis Obispo Co.

California: open slopes, hills 2 miles west of Belmont, San Mateo Co., May 25, 1932, *Keck 1873* (P); Calistoga, June, 1881, *Greene* (M, N); on the hills southeast of Napa, July 26, 1913, *Suksdorf 670* (M); Napa, April 24, 1924, *M. E. Jones* (PO); Napa, 1899, *Smyth* (G); Rebecca Ranch grade, April 30, 1894, *Jepson* (CAL); near St. Helena Sanitarium, Napa Co., July 2, 1916, *Abrams 5751* (NY); shallow clay soil of rocky hill, Black Point Road, Sonoma Co., July 13, 1930, *J. T. Howell 5338* (CAL, CAS type); clay soil, 4 mi. from Santa Rosa on road to Sonoma, Sonoma Co., June 9, 1929, *J. T. Howell 4304* (CAL, M, NY, US); north hillside, School Cañon, April 10, 1908, *Condit* (CAL); Knight's Valley, June 14, 1894, *Greene* (N); Ignatio, Marin Co., April 27, 1918, *Abrams 6889* (ST); Angel Island, San Francisco Bay, 1877, *Rattan* (ST); summit of Cuesta Pass, San Luis Obispo Co., July 2, 1933, *J. T. Howell 11415* (CAS, M); White's Hill, between Fairfax and Woodacre, Marin Co., July 30, 1933, *J. T. Howell 11463* (CAS, M).

### 42d. var. **brevisquama** f. **glabrata** Steyermark, f. nov.[59]

Stems practically glabrous; leaves mostly glabrous, firmly membranaceous to submembranaceous; involucral bracts glabrous.

Distribution: rocky or clay slopes, Sonoma Co., west-central California.

California: clay soil, 8 mi. west of Petaluma, on Bodega Road, Sonoma Co., June 8, 1930, *J. T. Howard 5222* (CAS), and *5221* (M type, CAS, G, PO, isotypes); Oakland, *Bolander 89* (M); rocky slope, 1 mi. east of Bodega Bay, Sonoma Co., June 8, 1930, *J. T. Howell 5256* (CAL, CAS); Glen Ellen, Sonoma Co., June, 1893, *Michener & Bioletti* (M, NY, PO).

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[59] **G. hirsutula** var. **brevisquama** f. **glabrata** Steyermark, f. nov., caulibus plus minusve glabris; foliis plerumque glabris, firme membranaceis vel submembranaceis; bracteis involucri glabris.—Collected in clay soil, 8 miles west of Petaluma, on Bodega Road, Sonoma Co., California, June 8, 1930, *J. T. Howell 5221* in part (Mo. Bot. Gard. Herb. no. 1016008 type, CAS, G, PO, isotypes).

**42e.** var. **brevisquama** f. **tomentulosa** Steyermark, f. nov.[60]

*G. hirsutula* Hook. & Arn. acc. to Gray in Geol. Surv. Cal. Bot. 1: 303. 1876, in part, and excluding *G. rubricaulis* and plants from Monterey and along coast to Puget Sound; acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, in part as to plant of *Kellogg* at Gray and Mo. Bot. Gard. Herb.

*G. rubricaulis* DC. acc. to Jepson, Fl. W. Mid. Cal. 554. 1901, and ed. 2. 462. 1911, in part as to plant of *Setchell* near Mt. Tamalpais; Man. Fl. Pl. Cal. 1020. 1925, in part as to plant of *Setchell* near Mt. Tamalpais.

Involucral bracts densely hirsutulous to tomentulose.

Distribution: dry banks and hillsides, mostly in the mountains, Marin, San Mateo, and Santa Clara Counties, California.

CALIFORNIA: redwoods, near San Francisco, 1866, *Kellogg* in part (G, M); dry bank (shale and sandstone), Los Trancos, Searsville Ridge, San Mateo Co., June 24, 1927, *Blake 9943* (G); dry bank, near Crystal Springs Lake, San Mateo Co., June 25, 1927, *Blake 9949* (G); Crystal Springs Lake, June 23, 1913, *Suksdorf 279* (M TYPE); Black Pt., Marin Co., *Hichborn* (ST); exposed slope, Pescadero-La Hondo Road, San Mateo Co., July 3, 1921, *Mason* (ST); Stanford University, Santa Clara Co., April, 1900, *Atkinson* (ST).

**42f.** var. **brevisquama** f. **pedunculoides** Steyermark, f. nov.[61]

Stems stout, sparsely or loosely crisp- or villous-puberulent, branching above with several stout elongated floriferous branchlets 1.5–4 dm. long; leaves entire to serrulate, 8–10 cm. long, 1.2–1.6 cm. broad, oblong, subamplexicaul, those on the floriferous branchlets reduced towards the heads, the upper scattered and much reduced, crisp- or villous-puberulent on both surfaces; disk 1.0–1.2 cm. high, 1.7–2 cm. broad; involucral bracts glabrate to puberulent.

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[60] **G. hirsutula** var. **brevisquama** f. **tomentulosa** Steyermark, f. nov., bracteis involucri dense hirsutulis vel tomentulosis, multo pubescentioribus quam var. *brevisquama*.—Collected at Crystal Springs Lake, San Mateo Co., California, June 23, 1913, *Suksdorf 279* (Mo. Bot. Gard. Herb. no. 850778 TYPE).

[61] **G. hirsutula** var. **brevisquama** f. **pedunculoides** Steyermark, f. nov., caulibus robustis, parce vel laxe crispo- vel villoso-puberulis, supra ramosis cum ramusculis floriferis paucis robustis elongatis; foliis integris vel serrulatis, 8–10 cm. longis, 1.2–1.6 cm. latis, oblongis, subamplexicaulibus, illis in ramusculis floriferis adversum capitula reductis; ramusculis floriferis 1.5–4 dm. longis, ut videtur prope capitula pedunculiformibus; disco 1–1.2 cm. alto, 1.7–2 cm. lato; bracteis involucri glabratis vel puberulis.—Collected at Calistoga, California, May 7, 1900, *Eastwood* (Univ. Cal. Herb. TYPE, G isotype).

Distribution: Napa Co., California.
CALIFORNIA: Calistoga, May 7, 1900, *Eastwood* (CAL TYPE, G).

**42g.** var. **calva** Steyermark, var. nov.[62]

Stems glabrous to sparsely puberulent; leaves firm and subcoriaceous, the main cauline 2–5.5 cm. long, 0.4–1 cm. broad, 5–9 times longer than broad, linear or linear-oblong, mostly acute, about as broad at the base as at the middle, scabridulous along the margins or sometimes on the surface, the lower and middle cauline rather closely serrulate or denticulate with short sharply acute to subspinulose-tipped teeth from base to apex (rarely subentire); involucral bracts glabrous or glabrate, 4–6-seriate, 4–8 mm. long, linear-lanceolate to lanceolate, gradually acuminate, appressed or very slightly spreading at the tips, the outer bracts short.

Distribution: San Luis Obispo Co., southern California.
CALIFORNIA: San Luis Obispo, spring, 1905, *Roadhouse 65* (CAL TYPE); San Luis Obispo, June 26, 1876, *Ed. Palmer 249* (CAL, NY, US).

**42h.** var. **subintegra** Steyermark in Ann. Mo. Bot. Gard. **21**: 229. 1934.

Stems more or less puberulent; leaves entire or subentire, sometimes the basal and others serrate, oblong to ovate-oblong, 2–13 cm. long, 0.7–3.5 cm. broad, finely puberulent to glabrate, the upper with subamplexical bases; involucral bracts 3–7 mm. long, glabrous, with erect or ascending short acute to acuminate tips.

Distribution: dry open hills and fields, Ventura Co., southern California.
CALIFORNIA: on grassy hillside, 2 mi. east of Ojai, Ventura Co., July 1, 1933, *J. T. Howell 11414* (M TYPE, CAS isotype); dry field, Ojai, Ventura Co., June 4, 1927, *Hoffmann* (SB).

The identification of this species with *G. rubricaulis* by many authors has led to the greatest amount of disorder among the Californian species. An examination of a fragment and photograph of the type of *G. hirsutula* shows the stems villous- or crisp-pubescent and the outer and middle involucral bracts hirsutulous throughout; the inner and middle bracts are erect with mostly straight tips, while the outer are loose with spreading or slightly recurved slender tips; some of the heads are immediately subtended by slightly enlarged upper leaves; this type of involucre is matched by present collections obtained from the Sausalito Hills region northwest across San Francisco Bay from San Francisco, which may be where Lay and Collie collected their plant although it is more likely that they obtained it from San Francisco. The historical type of *G. hirsutula* may therefore be identified with a form common around Sausalito, a form which is a less usual phase of the *G. hirsutula* group. The commoner type of involucre is represented by var. *brevisquama* and forms, in which the bracts are more obviously graduated and appressed, and are broadly or ovate-lanceolate with shorter acute to short subulate erect tips. A more foliaceous development of the involucral bracts occurs especially in the Berkeley hills region of California. Greene described this foliaceous type as a species, *G. patens,* but detailed study of the *G. hirsutula* group shows various intergradations between the type of involucre in *G. hirsutula* and in *G. patens,* so that *G. patens* should, at most, be recognized as only an extremely foliaceous form of *G. hirsutula.*

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[62] **G. hirsutula** var. **calva** Steyermark, var. nov., caulibus plerumque glabris, simplicibus; foliis firmis et subcoriaceis, contigue serrulatis vel denticulatis cum dentibus brevibus acutis vel subspinulosis, glabris; bracteis involucri glabris vel glabratis.—Collected at San Luis Obispo, California, spring of 1905, *F. E. Roadhouse 65* (Univ. Cal. Herb. TYPE).

Some authors, notably Jepson and Greene, in treating *G. hirsutula* and *G. rubricaulis* conspecifically, gave priority to *G. rubricaulis* DC. (1836) over *G. hirsutula* Hook. & Arn. (1833). There is no justification for this view, however, since the proper date of publication for *G. hirsutula* Hook. & Arn. is 1833, rather than later as was assumed, and that of *G. rubricaulis* DC. is 1836.

**43. G. maritima** (Greene) Steyermark, comb. nov.

*G. glutinosa* (Cav.) Dunal acc. to Gray in Geol. Surv. Cal. Bot. 1: 303. 1876, as to plant from Fort Point.

*G. rubricaulis* DC. var. *maritima* Greene, Pitt. 2: 289. 1892; Man. Bot. San Franc. Bay Reg. 172. 1894; Jepson, Fl. W. Mid. Cal. 554. 1901, and ed. 2. 461. 1911, as to synonym only; Man. Fl. Pl. Cal. 1020. 1925, as to synonym only.

*G. robusta* var. *maritima* (Greene) Jepson, Fl. W. Mid. Cal. 554. 1901, and ed. 2. 461. 1911, as to name-bringing synonym, not as to description nor plants from Olema and Pilarcitos; Man. Fl. Pl. Cal. 1020. 1925, as name-bringing synonym, not as to description nor plants from Olema and Pilarcitos.

Herbaceous perennial; stems decumbent to ascending, often leaning, slender, the floriferous branchlets loosely corymbosely branched with elongated divergent branchlets bearing few heads, or the branchlets simple or scarcely branched and sometimes with only 1 head, mostly rufous-brown to reddish-purple, usually glabrous, 3.5–5 or more dm. tall; leaves mostly firm and subcoriaceous, pale grass-green to bright green, inconspicuously resinous-punctate, the main cauline closely crenate, sinuate-dentate to dentate or subentire, those on the floriferous branchlets denticulate to entire, basal and lowermost leaves never incised-dentate or pinnatifid, the main middle and lower cauline 3.5–8 cm. long, 0.9–2.8 cm. broad, 3–6 times longer than broad, those on floriferous branchlets 1–3 cm. long, 0.5–1 cm. broad, 2–3½ times longer than broad, the main middle and lower cauline oblong-spatulate or oblong-oblanceolate to broadly or ovoid-oblong, mostly obtuse, amplexicaul, those on floriferous branchlets ovate-oblong or oblong-lanceolate, acute to obtusish, amplexicaul, glabrous; head 3.5–4.2 cm. broad; disk campanulate-hemispherical, 0.9–1.2 cm. high, 1.7–2 cm. broad; involucre resinous, especially so before anthesis, 4–5-seriate, the bracts mostly erect and appressed or the short upper fourth to fifth spreading or ascending (rarely reflexed), 4–9 mm. long, mostly lanceolate to oblong-lanceolate with rather abruptly acuminate or short caudate flattened tips, glabrous; receptacle conspicuously foveolate; rays 25–35, bright orange-yellow, the lamina 11–15 mm. long; stigmas oblong-lanceolate, moderately exserted; achenes 3.5–4.2 mm. long, 1.8–2 mm. broad, oblong, light brown to dark brown, irregularly furrowed or ribbed, apex slightly bordered or with 2–3 short knobs or projections; awns mostly 2 to the floret, stoutish, remotely to numerously serrulate or setulose, 3–5.2 mm. long, ⅖–¾ length of disk-floret.

Distribution: sandy or serpentine dry slopes adjacent to the ocean, at the tip of the peninsula around San Francisco, Presidio, Pt. Lobos, Fort Winfield Scott, and Lake Merced in San Mateo Co., central California.

CALIFORNIA: Lake Merced, Oct. 20, 1897, *Davy* (CAL); San Francisco, Sept., 1901, *T. S. Brandegee* (CAL); Lake Merced, San Francisco, Oct. 19, 1924, *J. T. Howell 709* (CAS); shallow soil overlying serpentine, Presidio near Fort Point, San Francisco, Aug. 11, 1933, *J. T. Howell 11489* (CAS, M); San Francisco, Aug., 1891, *T. S. Brandegee* (CAL); dry banks, Presidio, San Francisco, July 6, 1927, *Blake 10000* (G); summit of Twin Peaks, San Francisco, Sept. 15, 1933, *J. T. Howell 11661* (CAS, M); dry hill, Presidio, San Francisco, July 6, 1927, *Blake 9998* (G); sandy bluffs, Lincoln Park, San Francisco, Aug. 3, 1927, *Blake 10159* (G); exposed slope near sea, Ft. Winfield Scott, San Mateo Co., alt. 35 m., Aug. 8, 1931, *Moore & Steyermark 3685* (M); Lake Merced, San Francisco, Oct. 5, 1895, *Eastwood* (G); Pt. Lobos, Aug. 12, 1892, *Greene* (CAL, N TYPE); Laguna Honda, San Francisco, Sept. 15, 1933, *J. T. Howell 11656 and 11657* (CAS, M).

**43a. f. anomala** Steyermark, f. nov.[63]

Stems pubescent; leaves glabrate to sparsely pilose on midrib beneath.

Distribution: region of San Francisco, San Mateo Co., California.

CALIFORNIA: Laguna Honda, San Francisco, Sept. 15, 1933, *J. T. Howell 11658* (M TYPE, CAS isotype); summit of Twin Peaks, San Francisco, Sept. 15, 1933, *J. T. Howell 11662* (CAS, M cotype); summit of Twin Peaks, San Francisco, Sept. 15, 1933, *J. T. Howell 11660* (CAS, M).

The complexities of *Grindelia* must indeed have been overwhelming for Greene to have described two varieties within one genus, an act which he committed for *G. rubricaulis* var. *maritima* Greene and *G. robusta* var. *platyphylla* Greene. One might suppose that if Greene, notorious splitter that he was, described them as varieties, they might automatically become mere forms or direct synonyms, but the curious point is that *G. rubricaulis* var. *maritima* should be elevated to specific rank and considered a fairly distinct species. True, it does show close affinity to *G. hirsutula*, with which Greene intended to indicate its varietal relationship (he placed it under *G. rubricaulis* which at that time was considered synonymous with and published before *G. hirsutula*). Although *G. maritima* sometimes approaches glabrous forms of *G. hirsutula*, it may usually be distinguished from that species by the combination of mostly glabrous stems and glabrous firmer leaves which have more amplexicaul leaf-bases, more divergently and loosely corymbose branchlets, and more numerously serrulate pappus awns. Moreover, the basal and lowermost leaves of *G. hirsutula* are often incised-dentate or pinnatifid, whereas in *G. maritima* they are never pinnatifid or deeply dentate. In *G. maritima* the leaves on the floriferous branchlets are ovate to oblong-lanceolate and strongly amplexicaul, and mostly 2–3½ times longer than broad, whereas in the *G. hirsutula* group they are narrower—oblong to linear—and 3–6 times longer than broad. Although it is admitted that *G. maritima*

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[63] **Grindelia maritima** f. **anomala** Steyermark, f. nov., caulibus et foliis pubescentibus. Collected at Laguna Honda, San Francisco, Sept. 15, 1933, *J. T. Howell 11658* (Mo. Bot. Gard Herb. no. 1044116 TYPE, CAS isotype).

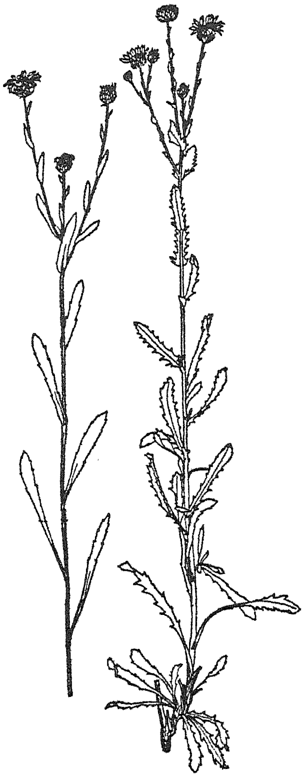

Fig. 35. *G. hirsutula.* × ⅙.

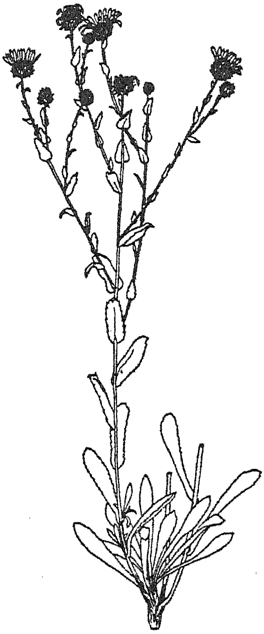

Fig. 36. *G. maritima.* × ⅙.

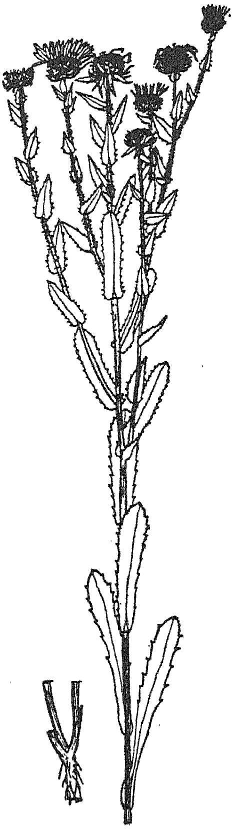

Fig. 37. *G. rubricaulis.* × ⅙.

is very close to *G. hirsutula,* it appears distinct enough in several ways to be maintained as a valid species.

Jepson confused matters greatly in transferring Greene's *G. rubricaulis* var. *maritima* to *G. robusta* with which it is not related. Moreover, he misinterpreted *G. rubricaulis* var. *maritima* Greene, since he not only introduced new heterogeneous elements into its original interpretation by citing plants from Olema and Pilarcitos, but also, in identifying Greene's variety with *G. robusta,* he caused *G. robusta* var. *maritima* to become a name-bringing synonym of *G. maritima* (*G. rubricaulis* var. *maritima* Greene). The plants from Olema and Pilarcitos are conspecific with *G. hirsutula* f. *patens,* and thus *G. robusta* var. *maritima,* excluding *G. rubricaulis* var. *maritima,* is both a direct synonym (as to *G. hirsutula* f. *patens*) and a name-bringing synonym (as to *G. maritima*).

**44. G. rubricaulis** DC. Prodr. **5**: 316. 1836, not *G. rubricaulis* of authors, which is *G. hirsutula* Hook. & Arn.; Torr. & Gray, Fl. N. Am. **2**: 247. 1842, as to synonym, plant of *Douglas,* and description in part; Gray in Geol. Surv. Cal. Bot. **1**: 303. 1876, as to synonym mainly; Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, as to synonym, plant of *Douglas,* and description in part; Greene, Man. Bot. San Franc. Bay Reg. 171. 1894, as to name only; Jepson, Fl. W. Mid. Cal. 555. 1901, and ed. 2. 462. 1911, as to name only; Man. Fl. Pl. Cal. 1020. 1925, as to name only.

*G. hirsutula* Hook. & Arn. acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 117. 1884, and ed. 2. 117. 1888, in part, at least as to description "with . . . subulate-attenuate squarrose tips and with . . . the surrounding loose foliaceous bracts" and plants of *Brewer 657 (Guirado), Kellogg* (in part, specimens in Gray and U. S. Nat. Herb.) and *Douglas 55.*

Herbaceous perennial; stems slender, reddish-purple or purplish-brown to sometimes buff or greenish-brown below, more or less villous-pubescent above the middle, 2.7–8 dm. tall; leaves firmly membranaceous, dark green, scarcely resinous-punctate, the main cauline remotely to coarsely and sometimes saliently or incised-dentate, the upper saliently dentate or more often becoming entire, the main lower and middle cauline 5–11 cm. long, 1–2.5 cm. broad, 4 to 5½ times longer than broad, those on the elongated floriferous branchlets 1.0–4 cm. long, 0.4–1.3 cm. broad, 2½–5 times longer than broad, the main middle and lower cauline oblong or oblong-spatulate, mostly obtuse or obtusish, subamplexicaul or narrowed at base, the middle cauline subamplexicaul, the upper cauline and those on floriferous branchlets triangular-ovate or ovate-lanceolate to lanceolate, acute, strongly amplexicaul, mostly sparsely villous or crisp-pubescent on both surfaces or (especially the lower) becoming glabrate, the margins usually villous-ciliate; heads mostly 4–5 cm. broad; disk depressed-hemispherical, 1.0–1.3 cm. high, 1.7–2.5 cm. broad; involucre moderately resinous on the innermost bracts, bracts mostly 5–6-seriate, 4–10 mm. long, the upper fifth to half free and moderately to strongly reflexed, the outermost becoming loose and foliaceous and passing more or less into the subtending involucral leaves, the outer and middle linear-lanceolate to lanceolate with subulate or long acuminate mostly flattened tips, crisp- or villous-pubescent to hirsutulous, sometimes glabrate; rays 27–35, bright chrome-yellow to orange-yellow, the lamina 12–18 mm. long; stigmas oblong-lanceolate; achenes oblong, 3–4 mm. long, 1.5–1.7 mm. broad, light brown to buff, smooth to slightly striated or furrowed, obliquely bordered at apex with an auriculate undulate crown; awns 2–7 to the floret, stout or stoutish, entire to remotely serrulate, 2.8–5.2 mm. long, often ½–⅔ length of disk-floret.

Distribution: Santa Clara, Santa Cruz, Monterey, and San Benito Counties, California.

CALIFORNIA: in pasture near Pescadero Ranch, Monterey Co., May 25, 1861, *Brewer 657* (*Guirado*) (CAL, G, US); near Del Monte Lodge on Carmel Bay, Monterey Co., among *Pinus radiata*, Aug. 19, 1933, *J. T. Howell 11602* (CAS, M); near Santa Rita, Monterey Co., May, 1889, *Abbott* (CAS); 1833, *Douglas 55* (CAL photograph and fragment of TYPE, G isotype and photograph of TYPE, M photograph of TYPE); Monterey, June 14, 1889, *K. Brandegee* (CAL); Santa Lucia Mts., Monterey Co., Aug. 1885, *T. S. Brandegee* (G); pine forest at Pacific Grove, Aug. 16, 1905, *Coleman* (ST); Swanton, spring of 1912, Santa Cruz Co., *Rich* (ST); Swett's Ranch, May 22, 1887, *Rattan* (ST); Pacific Grove, June 12, 1907, *Patterson & Wiltz* (ST).

**44a.** var. **permixta** Steyermark, var. nov.[64]

Stems glabrous to more or less villous-pubescent, simple or sparingly branched above; leaves dentate or denticulate to entire, the main middle and lower cauline 4–6.5 cm. long, 0.5–0.8 cm. broad, 6–9 times longer than broad, the upper 1.5–4 cm. long, 1.5–6 mm. broad, 6–12 times longer than broad, narrowly oblanceolate to linear-oblong or lanceolate, acute to acuminate, subamplexicaul or not narrowed at the base, glabrous to more or less villous-pubescent; involucral bracts crowded, numerous, slender, the outer becoming foliaceous, the free upper portion deflexed to rather openly recurved, linear- to narrowly lanceolate with slender subulate tips, glabrous to more or less villous-puberulent.

Distribution: rocky bluffs and open places, about Oakland and San Leandro, Alameda Co., California.

CALIFORNIA: rocky bluff, San Leandro, Alameda Co., July 22, 1929, *J. T. Howell 4352* (CAS TYPE); San Leandro, June, 1888, *Underwood* (NY); San Leandro, Contra Costa Co., June 21, 1915, *Eastwood 4730* (CAS, US); East Oakland, July 7, 1907, *Walker 689* (CAL).

**44b.** var. **elata** Steyermark in Ann. Mo. Bot. Gard. **21**: 227. 1934.

*G. camporum* Greene acc. to Abrams, Fl. Los Ang. & Vic. 393. 1904, and ed. 2. 360. 1917, as to plant from Wiseburn only; acc. to Hall, U. Cal. Publ. Bot. [Compos. S. Cal.] **3**: 39. 1907, only as to plants of *Cleveland, Chandler 5358, Hall 6726,* and *Brandegee,* Ramona, July 10, 1903.

*G. robusta* Nutt. acc. to Jepson, Man. Fl. Pl. Cal. 1020. 1925, in small part and especially as to plants from San Diego Co.

Stems erect, one to few, stout, strongly corymbosely branched above with mostly elongated ascending floriferous branchlets usually bearing many heads, mostly buff or stramineous, glabrous, 6–12 dm. tall; leaves firmly membranaceous or subcoriaceous, dark green or olive-green, moderately to abundantly resinous-punctate, coarsely or saliently dentate or serrate with acute to sharply acuminate teeth, or finely serrate, those on the floriferous branchlets often entire or subentire, the main middle and lower cauline 3.5–7.5 cm. long, 0.7–1.8 cm. broad, 3–9 times longer than broad, those on floriferous branchlets numerous, 1–2.3 cm. long, 0.2–1 cm. broad, mostly 1½–3 times longer than broad, becoming smaller towards the heads, the main middle and lower cauline linear- or narrowly oblong or oblanceolate to oblong-lanceolate, acute to obtuse, mostly narrowed at the base to subamplexicaul, the upper cauline and those on floriferous branches lanceolate to ovate, acute to acuminate, strongly amplexicaul, glabrous except for the scabridulous margins; involucre conspicuously and abundantly resinous, about 6–7-seriate, the upper ⅕–⅓ of the bracts strongly reflexed to revolute, those at the base mostly crowded and revolute, infrequently loose or foliaceous, tips thickened and subcoriaceous; lamina of rays 8–12 mm. long; awns 2–3 to the floret, mostly 2, entire, ½–¾ length of disk-floret.

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[64] **G. rubricaulis** var. **permixta** Steyermark, var. nov., caulibus glabris, plus minusve villoso-pubescentibus, simplicibus vel supra parce ramosis; foliis caulinis principalibus inferioribus et mediis dentatis vel denticulatis vel integris, 4–6.5 cm. longis, 0.5–0.8 cm. latis, 6–9 plo longioribus quam latis, lineari-oblongis vel lanceolatis vel anguste oblanceolatis, superioribus plerumque integris vel denticulatis, 1.5–4 cm. longis, 1.5–6 mm. latis, 6–12 plo longioribus quam latis, lanceolatis vel lineari-lanceolatis vel linearibus, glabris vel plus minusve villoso-pubescentibus; bracteis involucri congestis, tenuibus, exterioribus foliaceis, parte superiore libera lineari- vel anguste lanceolata, apicibus tenuibus villoso-puberulis.—Collected on rocky bluff, San Leandro, Alameda Co., California, July 22, 1929, *J. T. Howell 4352* (Cal. Acad. Sci. Herb. no. 165887 TYPE).

Distribution: dry hills and canyons in mountains, clay soil of coastal mesas and flats, fields and waste places, along the coast and slightly inland, Santa Barbara Co., California; south to the vicinity of San Ysidro, northwestern Lower California. The common gumweed around San Diego and adjacent regions.

United States: California: state highway north of Oceanside, San Diego Co., alt. 100 ft., Dec., 1916, *Reed 3927* (CAL); National City, July 3, 1885, *Cleveland* (CAL); dry mesa, La Presa, San Diego Co., June 6, 1903, *Abrams 3903* (CAL, F, G, M, NY, PA, PO, US); Oceanside, San Diego Co., alt. 0–50 ft., June 11–16, 1897, *Parish 4452* (G, M, MA, NY, US); hills, Los Angeles Co., July, 1889, *Hasse* (M); Lemon Grove, July, 1897, *Rodman* (G); grassland, old clearing, La Jolla, June 6, 1914, *F. E. & E. S. Clements 243* (CAL, F, G, M, NY, PA); hills of Santa Monica Mts. at Santa Monica, Los Angeles Co., May 29, 1931, *J. T. Howell 6562* (CAS); coastal flat at Little Sycamore Creek, Malibu Highway to Oxnard, Ventura Co., May 29, 1931, *J. T. Howell 6566* (CAS, M); Conejo Valley, Ventura Co., May 29, 1931, *J. T. Howell 6573* (CAS); clay hills, 7 mi. southwest of Simi, Ventura Co., May 29, 1931, *J. T. Howell 6574* (CAS type); Ramona, July 10, 1903, *T. S. Brandegee* (CAL, PA); San Diego, 1902, *T. S. Brandegee* (CAL); clay soil of coastal mesa, San Clemente, Orange Co., June 1, 1931, *J. T. Howell 6624* (CAS).

Mexico: Lower California—San Ysidro Ranch, July 2, 1894, *Mearns 3858* (US); San Ysidro, June 28, 1894, *Schoenfeldt 3806* (NY, US).

**44c.** var. **bracteosa** (J. T. Howell) Steyermark in Ann. Mo. Bot. Gard. **21**: 227. 1934.

*G. bracteosa* J. T. Howell in Madroño **2**: 22. 1931.

Stems glabrous, corymbosely branched above with divergently ascending stout floriferous many-headed branchlets; leaves dark green, moderately resinous-punctate, coarsely and sharply serrate to serrulate, the upper cauline and those on floriferous branchlets 2–3 cm. long, 0.5–1.0 cm. broad, 3–3½ times longer than broad, ovate- to oblong-lanceolate, acute, subamplexicaul, those on floriferous branchlets crowded and not reduced below the heads; heads large, discoid; disk depressed-hemispherical, 1.7–2.5 cm. broad, 1.0–1.5 cm. high; involucre conspicuously and abundantly resinous, 6–7-seriate, the bracts strongly reflexed to revolute with thickened and subcoriaceous tips, the outermost bracts at the base mostly crowded and revolute, frequently subtended by foliose leaves; awns 2–6, entire, ½–⅝ length of disk-floret.

Distribution: dry clay soil of hills and canyons, Santa Ana Canyon, Orange Co., Puente and Chino Hills, San Bernardino Co., and Pine Hills, San Diego Co., California.

California: road to Aliso Canyon, s. Puente Hills, San Bernardino Co., alt. ca. 1000 ft., June 6, 1928, *Johnson* (CAS); in hard dry soil, hills on n. side of Santa Ana Canyon, Orange Co., alt. 600 ft., July 16, 1927, *J. T. Howell 2786* (CAS type); ad silvarum margines Pine Hills, San Diego Co., alt. 1500 m., July 10, 1918, *Spencer* (CAL); heavy soil along the creek banks, Chino Creek south of Ontario, alt. 500 ft., May 26, 1918, *I. M. Johnston* (PO).

**44d.** var. **robusta** (Nutt.) Steyermark in Ann. Mo. Bot. Gard. **21**: 227. 1934.

*G. robusta* Nutt. Trans. Am. Phil. Soc. N. S. **7**: 314. 1841; Torr. & Gray, Fl. N. Am. **2**: 247. 1842; Walp. Rep. Bot. Syst. **2**: 585. 1843; Gray in Geol. Surv. Cal. **1**: 304. 1876; Rothrock, Rept. Wheeler Exp. **6**: 363. 1878; Gray, Syn. Fl. N. Am. **1**$^2$: 119. 1884, and ed. 2. 119. 1888; Abrams, Fl. Los Ang. & Vic. 393. 1904, and 361. 1917, in major part; Perredes, Wellcome Chem. Res. Lab. 65:2, *pl. 1, fig. 1,* and *1a.* 1906; Hall in U. Cal. Publ. Bot. [Compos. S. Cal.] **3**: 38. 1907, excluding plant of

*Eastwood;* Jepson, Man. Fl. Pl. Cal. 1020. 1925, in part and excluding at least plants from San Diego and San Francisco region.

*G. cuneifolia* Nutt. Trans. Am. Phil. Soc. N. S. **7**: 315. 1841, not of authors; acc. to Torr. & Gray, Fl. N. Am. **2**: 247. 1842; acc. to Walp. Rep. Bot. Syst. **2**: 586. 1843; acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 118. 1884, and ed. 2. 118. 1888, as to name and as to plant from Santa Barbara; acc. to Greene, Man. Bot. San Franc. Bay Reg. 172. 1894, as to name only; acc. to Greene, Fl. Franc. pt. 4. 363. 1897, as to name only; acc. to Jepson, Fl. W. Mid. Cal. 555. 1901, and ed. 2. 462. 1911, as to name only; acc. to Abrams, Fl. Los Ang. & Vic. 393. 1904, and ed. 2. 361. 1917, as to name only; acc. to Hall in U. Cal. Publ. Bot. [Compos. S. Cal.] **3**: 38. 1907, as to name and as to plant from Santa Barbara, not as to description; acc. to Jepson, Man. Fl. Pl. Cal. 1021. 1925, as to name only.

*G. pacifica* Jones in Bull. Torr. Bot. Club **9**: 31. 1882; Gray, Syn. Fl. N. Am. **1**$^2$: 119. 1884, and ed. 2. 119. 1888, as synonym.

Stems one to several, stout, the floriferous branchlets bearing few to several heads, glabrous, 4–12 dm. tall, uniformly foliose throughout; leaves firmly membranaceous, moderately resinous-punctate, coarsely saliently dentate or serrate with large broad acute to spinulose teeth, or the uppermost often entire or subentire, 2.5–9 cm. long, 0.7–3 cm. broad, 2–4½ times longer than broad, the main middle and lower cauline oblong to ovate-oblong, obtuse to acute, mostly conspicuously amplexicaul, the upper cauline and those on floriferous branchlets lanceolate to ovate-lanceolate, mostly acute or obtuse, strongly amplexicaul, glabrous except for the scabridulous margins; heads radiate, mostly 3–5 cm. broad; disk depressed-hemispherical, 0.9–1.3 cm. high, 1.5–3 cm. broad; involucre moderately resinous, the upper fourth to half of the bracts free and only moderately reflexed, sometimes spreading, mostly flattened and scarcely thickened, the outermost becoming loose and foliaceous and passing more or less into the subtending involucral leaves, submembranaceous, glabrous; rays

30–47, lamina mostly 12–17 mm. long; awns 2–7 to the floret, usually stout, entire to remotely serrulate, ½–¾ length of disk-floret.

Distribution: clay soil of coastal slopes and flats, wet places on coastal mesas and low ground, from Orange Co. north along the coast to San Luis Obispo Bay and Cambria, San Luis Obispo Co., also around Santa Cruz and Monterey Counties, best developed on open coastal slopes in Los Angeles, Santa Barbara, and San Luis Obispo Counties.

CALIFORNIA: near Soldier's Home, Los Angeles Co., Sept., 1905, *Adams* (CAL); Oak Knoll, May 5, 1901, *Braunton 46* (US); dry soil, Whittier, June, 1892, *McClatchie* (NY); bluffs along shore, Laguna Beach, May 5, 1916, *Crawford* (PO); dry hills overlooking the sea, Carmel Mission, Aug. 10, 1896, *Jepson* (CAL); low ground near Summerland, Santa Barbara Co., Aug. 22, 1904, *Abrams 4105* (NY); Santa Barbara, July, 1875, *Rothrock 84* (F, G, US); clay soil of coastal bluff, Summerland, Santa Barbara Co., May 19, 1930, *J. T. Howell 5179* (CAS); St. Pedro, *Nuttall* (G, PA, isotypes); Avila, San Luis Obispo Co., May 3, 1926, *Eastwood 13763* (CAS); Elysian Park, Los Angeles Co., June 1, 1902, *Braunton 399* (US); Aptos, Santa Cruz Co., Oct. 13, 1902, *Abrams 3072* (PO); Morro, San Luis Obispo Co., alt. 300 ft., June 30, 1927, *Feudge 1813* (PO); roadside, Morro Creek, San Luis Obispo Co., alt. 300 ft., March 24, 1925, *Munz 9229* (PO); Summerdale, Santa Barbara Co., May 7, 1902, *H. M. Hall 3175* (CAL); foothills back of Santa Barbara (Montarioso), alt. 400 ft., May 14, 1907, *H. M. Hall 7712* (CAL); near Morro, San Luis Obispo Co., May 25, 1892, *Summers* (CAL); Santa Barbara, *Nuttall* (G isotype of *G. cuneifolia*); Seabright, Santa Cruz Co., July 6, 1920, *Hichborn 321* (ST); Santa Cruz, Santa Cruz Co., Oct. 3, 1896, *Dudley* (ST); coast trail, Monterey Co., Aug. 17, 1903, *Dudley* (ST).

**44e.** var. **latifolia** (Kellogg) Steyermark in Ann. Mo. Bot. Gard. **21**: 227. 1934.

*G. latifolia* Kellogg in Proc. Cal. Acad. **5**: 36. 1873; Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876; Syn. Fl. N. Am. **1**$^2$: 119. 1884, and ed. 2. 119. 1888, as synonym; Greene, Pitt. **1**: 89. 1887; Hall in U. Cal. Publ. Bot. [Compos. S. Cal.] **3**: 37. 1907; Jepson, Man. Fl. Pl. Cal. 1020. 1925, as synonym.

*G. glutinosa* (Cav.)[65] Dunal acc. to Gray, Syn. Fl. N. Am. **1**$^2$:

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[65] The name *Grindelia glutinosa* has been so misinterpreted that it seems appropriate at this place to give it discussion, especially since it has not been satisfactorily placed by Cabrera in his revision of the South American species of *Grindelia*.

**Grindelia glutinosa** (Cav.) Dunal in Mem. Mus. Par. **5**: 49. 1819; acc. to Gray in Geol. Surv. Cal. Bot. **1**: 303. 1876, as to synonymy, not as to specimens cited from California; acc. to Gray, Syn. Fl. N. Am. **1**$^2$: 119. 1884, and ed. 2. 119. 1888, as to synonymy mostly.

*Aster glutinosus* Cav. Ic. **2**: 53. *pl. 168.* 1793.
*Doronicum glutinosum* Willd. Sp. Pl. **6**$^3$: 2115. 1800.
*Inula glutinosa* Pers. Syn. Pl. **2**: 452. 1807.

119. 1884, and ed. 2. 119. 1888, only as to plants of Santa Barbara Island, California, and including reference to *G. latifolia;* acc. to Brandegee in Proc. Cal. Acad. II. **1**: 211. 1888.

*G. robusta* Nutt. acc. to Hall, U. Cal. Publ. Bot. [Compos. S. Cal.] **3**: 38. 1907, as to plants of *Eastwood* only.

*G. robusta* var. *latifolia* (Kellogg) Jepson, Man. Fl. Pl. Cal. 1020. 1925; Gray in Geol. Surv. Cal. Bot. **1**: 304. 1876.

Stems stout, subcorymbosely branched above, with stout divergently ascending floriferous branchlets bearing few heads, 5 or more dm. tall; leaves pale or grayish-green, slightly resinous-punctate, the main cauline remotely dentate or serrate or closely crenate-dentate with short broad acute to obtuse teeth, mostly 8–13 cm. long, 3–8 cm. broad, 1½–2 times longer than

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*Donia glutinosa* R. Br. in Ait. Hort. Kew. ed. 2. **5**: 82. 1813; acc. to Ker in Bot. Reg. **3**: *pl. 187.* 1817; acc. to Hook. Fl. Bor. Am. **2**: 25. [1834] 1840, in small part, as to synonymy only.

*Demetria glutinosa* Lag. Gen. & Sp. Nov. 30. 1816.

*Aurelia decurrens* Cass. Dict. Sci. Nat. **37**: 468. 1825.

*Grindelia peruviana* Schz.-Bip. in Bonplandia **4**: 54. 1856.

*Grindelia peruana* Schz.-Bip. in Lechler, Berber. Am. Austr. 57. 1857, as nomen nudum.

*Grindelia montana* Phil. Anal. Univ. Sant. **87**: 429. 1894; Cabrera in Rev. Mus. La Plata **33**: 224. 1931.

Specimens examined in addition to those cited by Cabrera under *G. montana*:

South America: Peru—shrub, 1–2 ft. high, Posco, between Mollendo and Arequipa, alt. about 550 m., March 30, 1915, *Cook & Gilbert 42* (US); 2 ft., bushy-branched, sandy hills, desert (after Oct. rains), Mollendo, Arequipa, Nov. 17, 1923, *A. S. Hitchcock 23375* (US); Chile—Arica, Oct., 1914, *Buinnier 4401* (US); Arica, Jan. 1, 1906, *Sargent* (M).

Without Definite Locality: ''Aster glutinosus Cav., sp. nov., Mexico,'' ex. herb. Musei Brittanici (US part of type, British Museum photograph of type, B); ''Doronicum glutinosum W., Aster Cav.'' (M).

It is curious to find that *Grindelia glutinosa* (Cav.) Dunal has passed unidentified. Cabrera in his revision of the South American species of *Grindelia* (Rev. Mus. La Plata **33**: 209. 1931) was unable to place *G. glutinosa*, and treated it among his excluded species, saying ''Existen además dos especies inclúdas, al parecer erróneamente, en la flora sudamericana. Son ellas *G. squarrosa* . . . y *G. glutinosa* (Cav.) Dun., que Hoffmann, Bentham y Hooker y Hicken citan para el Perú, y Bertero para Chile.

''En cuanto a *G. glutinosa*, las ejemplares de Bertero delien reerirse a *Haplopappus chrysanthemifolius* (Less.) DC. y los de Hicken a *G. Boliviana* Rusby. No sé a qué se deben las citas de Bentham y Hooker y Hoffmann; pero por mi parte, no conozco ninguna especie sudamericana que pueda identificarse con la lámina y descripcion de Cavanilles.''

I have before me type material of *Aster glutinosus* Cav. preserved in the United broad, those on floriferous branchlets 1.5–4 cm. long, 1–3 cm. broad, 1¼–2 times longer than broad, the main and lower cauline broadly or ovoid-oblong, obtuse, amplexicaul to subcordate, those on floriferous branchlets broadly ovoid-oblong, ovate, or suborbicular-ovate, obtuse to acute, strongly amplexicaul, glabrous, crowded subtending the heads; disk 1.1–1.7 cm. high, 1.5–2.5 cm. broad; involucre scarcely resinous, the resinous exudate appearing mostly in bud and before anthesis, the upper third to half of the bracts free and moderately reflexed or spreading, mostly flattened and not conspicuously thickened; awns stout, 2–9, entire to moderately serrulate.

Distribution: open slopes and mesas, Santa Barbara Islands and adjacent coastal California in Santa Barbara and San Luis Obispo Counties, California.

CALIFORNIA: Santa Margarita, San Luis Obispo Co., July 8, 1882, *Summers 386*

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States National Herbarium, as well as a photograph of type material taken by Dr. S. F. Blake in the British Museum of Natural History, and a sheet in the Missouri Botanical Garden Herbarium labelled "*Doronicum glutinosum, Aster* Cav.," undoubtedly part of authentic material of *Doronicum glutinosum* Willd. which is synonymous with *Aster glutinosus* Cav.

A comparison of these historical specimens with Cavanilles' excellent plate and clear description shows that they are indeed the plants described as *Aster glutinosus* by Cavanilles. The pappus awns of these specimens are stout and strongly and closely setulose. The next problem was to learn with what existing collections *Aster glutinosus* Cav. could be matched. Cavanilles (Icones **2**: 53–54. 1793), in his original diagnosis, had stated that he had seen flowering material of his new species in the Royal Gardens of Madrid, and gave the habitat as Mexico. However, no collections have ever been found in Mexico which could be identified with *Aster glutinosus.* Gray (Syn. Fl. N. Am. $1^2$: 119. 1884, and ed. 2. 119. 1888) assumed that this species originally came from the Pacific shores, and tried to identify Kellogg's plant of *Grindelia latifolia* (now *G. rubricaulis* var. *latifolia*) and Bolander's plant of *Grindelia venulosa* (now *G. stricta* f. *venulosa*), both Californian plants, with *Aster glutinosus.* Other authors correctly assumed the locality to be South America; Hoffmann, Bentham and Hooker, and Hicken believed the source of *Aster glutinosus* to be Peru. An examination of herbarium material from South America shows that the species which Cabrera treats in his revision as *G. montana* Phil. is conspecific with *Grindelia glutinosa* (Cav.) Dunal. Most of the herbarium material of this species comes from either the Arica region in Chile, or the Tacna-Arequipa region in Peru. All the specimens show the distinctive stout, strongly and closely setulose pappus awns so characteristic of *G. glutinosa,* as well as the large foliaceous ascending-spreading involucral bracts, and oblanceolate to obovate serrate leaves of this species.

This removes all doubt finally concerning the locality and exact identity of *G. glutinosa,* and leaves certain the fact that *G. glutinosa* is a South American species inhabiting a limited area in Peru and Chile.

in part, as to specimen on left (CAL); Santa Rosa Island, 1872–73, *Harford* (CAS, G TYPE); open mesa, Santa Rosa Island, April 8, 1930, *Hoffmann* (SB); San Miguel Island, Sept., 1886, *Greene* (US); Santa Rosa Island, June, 1888, *T. S. Brandegee* (CAL, G); open slopes, Anacapa, June 16, 1930, *Hoffmann* (SB); Concepcion to Jalama, Santa Barbara Co., alt. 30 m., March 29, 1924, *Eggleston 19587* (PO, US); Suey Creek road, May 27–June 10, 1906, *Eastwood 396* (CAL, CAS, US); Suey River, near the boundary between Santa Barbara and San Luis Obispo Counties, May 9, 1896, *Eastwood* (G).

**44f.** var. **latifolia** f. **minor** Steyermark, f. nov.[66]

Stems 4–4.5 dm. tall; main middle and lower cauline leaves 3–4 cm. long, 1.5–2.5 cm. broad, 1½–1¾ times longer than broad, broadly ovate-oblong or ovate, subcordate or strongly amplexicaul, the middle and lower cauline more sharply and saliently dentate or serrate with acute to spinulose teeth; heads subtended and almost concealed by broadly deltoid-ovate or broadly ovate leaves 1–1.5 cm. broad.

Distribution: coastal bluffs and slopes, Santa Barbara Co., California.

CALIFORNIA: ocean bluffs, Point Arguello, *Hoffmann* (SB); Santa Maria, *Blockman* (CAL); Casmailia sands, country adjacent to Santa Maria, June 13–July 3, 1906, *Eastwood 794* (CAS, G TYPE, US).

**44g.** var. **latifolia** f. **pubescens** Steyermark, f. nov.[67]

Stems villous.

Distribution: Monterey Co., California.

CALIFORNIA: between Lucia and Little's Hot Springs, Monterey Co., June 14, 1909, *K. Brandegee* (CAL TYPE).

**44h.** var. **platyphylla** (Greene) Steyermark in Ann. Mo. Bot. Gard. **21**: 227. 1934.

*G. glutinosa* (Cav.) Dunal acc. to Gray in Geol. Surv. Cal. Bot. **1**: 303. 1876, as to plant from Lobos Creek, near San Francisco; acc. to Gray, Syn. Fl. N. Am. $1^2$: 119. 1884, and ed. 2. 119. 1888, only as to plant from San Francisco Bay.

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[66] **G. rubricaulis** var. **latifolia** f. **minor** Steyermark, f. nov., caulibus 4–4.5 dm. altis; foliis principalibus mediis et inferioribus 3–4 cm. longis, 1.5–2.5 cm. latis, 1½–1¾ plo longioribus quam latis, late ovato-oblongis vel ovatis, subcordatis vel valde amplexicaulibus.—Collected on Casmailia sands, California, June 13–July 3, 1906, *Eastwood 794* (Gray Herb. TYPE, CAS, US, isotypes).

[67] **G. rubricaulis** var. **latifolia** f. **pubescens** Steyermark, f. nov., caulibus villosis. —Collected between Lucia and Little's Hot Springs, Monterey Co., California, June 14, 1909, *K. Brandegee*, as to specimen on left side of sheet (Univ. of Cal. Herb. no. 468770 TYPE).

*G. robusta* var. *platyphylla* Greene, Pitt. 2: 289. 1892; Jepson, Man. Fl. Pl. Cal. 1020. 1925.

Stems erect to spreading, 3–5 dm. tall, glabrous; leaves subcoriaceous or firmly membranaceous, thicker than var. *robusta,* coarsely dentate, closely denticulate to entire, the main lower and middle cauline 4–8 cm. long, 1.5–2.5 cm. broad, 2–3 times longer than broad, obtuse to truncate above, amplexicaul, those on the floriferous branchlets numerous, 1–2 cm. long, 0.7–1.5 cm. broad, 1¼–2 times longer than broad, typically obtuse or obtusish and strongly amplexicaul, the main middle and lower cauline broadly oblong to obovate- or rhomboid-oblong or spatulate, the upper cauline and those on floriferous branchlets broadly oblong to rhomboid, subtruncate to acute; involucre with the tips moderately to strongly reflexed, rather more resinous than var. *robusta.*

Distribution: California, mostly in vicinity of Pacific Grove, Monterey Co., in fields, coastal flats, and beaches, in Santa Cruz Co., San Mateo Co., Marin Co., and Santa Rosa and Anacapa Islands.

California: roadside, in the low land along the Salinas River road from Watsonville to Monterey, Monterey Co., Aug. 20, 1930, *Peirson 9244* (P); Monterey Co., *Abbott* (CAS); wet grounds of brackish marsh, mouth of Waddell Creek, 1.5 miles south of San Mateo Co. line, Santa Cruz Co., Oct. 19, 1932, *J. T. Howell 10862* (CAS, M); Pacific Grove, July 8, 1914, *Newell* (CAS); coastal flats, 17-mile Drive, Pacific Grove, Monterey Co., Aug. 3, 1930, *J. T. Howell 5430* (CAS, G, M); along the beach between Point Pinos and Pacific Grove, June 12, 1903, *Heller 6843* (CAL, D, F, G, M, MA, NY, PA, PO, US); near Castroville, Monterey Co., Oct. 31, 1908, *Dudley* (ST); sandy sea beach, Point Pinos, near Monterey, July 31, 1927, *Blake 10154* (G); Pacific Grove, Monterey Co., Sept., 1902, *Elmer 4065* (G, PO); bluffs of the sea-shore, Pt. Cabrillo, Monterey peninsula, Aug., 1917, *Parish 11459* (PO); Monterey and Pacific Grove, July, 1892, *Howe* (CAL type); ocean bluffs, Pigeon Point, San Mateo Co., June 23, 1933, *Demaree 10378* in part (M); Westpoint Road, Tamalpais, July, 1907, *K. Brandegee* in part (CAL).

**44i.** var. **platyphylla** f. **villosa** Steyermark, f. nov.[68]

*G. hirsutula* Hook. & Arn. acc. to Benth. Plant. Hartweg. 317. 1849; acc. to Gray in Geol. Surv. Cal. Bot. 1: 303. 1876, as to plant from Monterey; acc. to Gray, Syn. Fl. N. Am. $1^2$: 117. 1884, and ed. 2. 117. 1888, as to plant from Monterey.

[68] **G. rubricaulis** var. **platyphylla** f. **villosa** Steyermark, f. nov., caulibus et saepe foliis plus minusve villosis; foliis caulinis superioribus et illis in ramusculis floriferis plerumque acutis.—Collected at Pacific Grove, coast above Chinatown Point, Monterey Co., California, July 10, 1905, *C. P. Smith 1016* (Gray Herb. type).

Stem and often the leaves more or less villous; upper cauline leaves and those on floriferous branchlets obtuse to acute.

Distribution: occurring with the variety, Pacific Grove and vicinity, Monterey Co., and south along the coast to the vicinity of Morro, San Luis Obispo Co., California.

CALIFORNIA: in fields and pastures near Monterey, 1848, *Hartweg 1786* [*46*], (G, M); Castroville, April, 1889, *K. Brandegee* (CAL); bluff above sea, Willow Cr.–Morrow region, San Luis Obispo Co., July 30, 1920, *Pierson 2754* (P); Pacific Grove, Monterey Co., May 24, 1899, *Chandler 326* (M); Pt. Carmel, Monterey Co., June 6, 1901, *Setchell* (CAL); Cambria, April 29, 1926, *Eastwood 13674* (CAS); Pacific Grove, coast above Chinatown Point, Monterey Co., July 10, 1905, *C. P. Smith 1016* (G TYPE); Moss Beach, July 15, *K. Brandegee* in part (CAL); ocean bluffs, Pigeon Point, San Mateo Co., June 23, 1933, *Demaree 10378* in part (M); Pebble Beach Ravine, 17-mile Drive, April 30, 1910, *Randall 421* (ST); Carmel bluffs near the sea, Monterey Co., Aug. 17, 1909, *Abrams 4260* (ST).

Heretofore *G. rubricaulis* DC. has been considered to be synonymous with *G. hirsutula* Hook. & Arn., a fallacy which has led to much taxonomic and nomenclatural confusion among variations of *G. hirsutula, G. rubricaulis,* and *G. robusta* Nutt. The present author has had an opportunity of examining a fragment and photograph of the type (“California,” 1833, *Douglas 55*), as well as an isotype collection of *G. rubricaulis* in the Gray Herbarium. The Douglas specimen has red stems which are glabrous below and loosely villous above, especially towards the heads; the outer and middle involucral bracts are covered with a short crisp pubescence and have very slender definitely recurved tips, while the inner bracts have straight tips. A comparison of this specimen with that of the type collection of *G. hirsutula* shows that in the latter the outer bracts are only slightly recurved at the tips. Moreover, the main cauline leaves of the *G. rubricaulis* type and isotype specimens are firmer and much more saliently dentate than the corresponding ones of *G. hirsutula.* The uppermost leaves of *G. rubricaulis,* as shown on the type collections, are mostly triangular-ovate or ovate-lanceolate with strongly clasping bases, whereas in *G. hirsutula* the uppermost leaves are more oblong-lanceolate to oblong and less amplexicaul.

It is well known that Douglas, on one of his western trips, collected for a short time in the Monterey Bay region. Several specimens have been collected in that locality which seem to match the *Douglas* plant—such collections as "in pasture near Pescadero Ranch, Monterey Co., May 25, 1861, *Brewer 657 (Guirado)*," "near Santa Rita, Monterey Co., May, 1889, *Abbott*," "near Del Monte Lodge on Carmel Bay, Monterey Co., among *Pinus radiata*, Aug. 19, 1933, *J. T. Howell 11602*," and "Monterey, June 14, 1889, *K. Brandegee*."

These specimens have the strongly recurved or revolute slender involucral tips, more or less foliaceous outer bracts subtending heads (to a greater or lesser degree), triangular-ovate or ovate-lanceolate leaves on the floriferous branchlets, and sharply dentate cauline leaves, at least in part. The evidence, therefore, shows that the plant of Douglas is well matched by collections in the Monterey Bay region, where he undoubtedly collected it. The *G. rubricaulis* DC., not authors, has slender recurved or revolute-tipped involucral bracts, whereas the *G. hirsutula* Hook. & Arn. and varieties (*G. rubricaulis* of many authors, not DC.) have involucral bracts with shorter erect-appressed or ascending-spreading tips which only exceptionally become more recurved.

In view of the fact that *G. rubricaulis* DC. grades imperceptibly into villous forms of *G. robusta* var. *platyphylla* Greene, around Pacific Grove, Pt. Carmel region, and elsewhere around Monterey, and since *G. robusta* var. *platyphylla* intergrades into *G. robusta* and *G. robusta* var. *latifolia*, it becomes quite necessary, though very unfortunate, to consider all variations of the *G. robusta* Nutt. complex as belonging under *G. rubricaulis* DC., since this name, published in 1836, antedates by five years the date of publication of *G. robusta* Nutt. It would be well if it were possible to conserve the name *G. robusta* Nutt. as a unit specifically distinct from *G. rubricaulis* DC., and thereby prevent so many changes in nomenclature, but a very large series of specimens has shown a bewildering amount of variation and intergradation in pubescence, leaf shape, involucral bracts, size of heads, etc.

The real identity of *G. cuneifolia* Nutt., not authors, was solved only after several years of study. Nuttall had seen only two small branches (which he may not even personally have collected, but which may have been collected for him by some other party), one of which is preserved in the British Museum and the other at Gray Herbarium; both are fragmentary and were collected at Santa Barbara. In the few involucral bracts still attached to the head of the Gray Herbarium fragment the tips are recurved and the head subtended by numerous reduced leaves. Later, Nuttall's fragments were identified with the common salt-marsh species (*G. humilis* Hook. & Arn.) of San Francisco Bay, and in this way the true identity of *G. cuneifolia* Nutt. was obscured. Since no specimens which matched the salt-marsh plants of San Francisco Bay had ever been collected around Santa Barbara, a region much visited by botanical collectors, it became obvious that Nuttall had collected some species other than *G. humilis* of the salt marshes. Examination of numerous herbarium specimens of *Grindelia* collected from Santa Barbara and adjacent coastal region revealed the fact that *G. rubricaulis* var. *robusta* (*G. robusta* Nutt.) was the form commonly collected in that area, but the perplexing phase of the problem was that in all the collections examined the upper leaves averaged much broader and were of a different shape from the Nuttall fragment of *G. cuneifolia.* Finally, however, the present author had occasion to examine a collection from the Pomona College Herbarium of the *Abrams 3273* specimen, collected at San Juan Capistrano, Orange Co., April 19, 1903. Most of this material consisted of broader acute upper leaves, as is typical of the var. *robusta,* and this well matched the other collections of *Abrams 3273* from the University of California Herbarium, California Academy of Sciences Herbarium, and New York Botanical Garden Herbarium. However, in the lower center of the sheet in the Pomona College Herbarium is a fragment of an upper branch of the *Abrams 3273* plant, which in all respects matches perfectly the type of *G. cuneifolia* Nutt. Furthermore, in growing from seeds plants of typical *G. rubricaulis* var. *robusta* collected by *J. T. Howell 5179* from Summerland (near Santa Barbara), Santa Barbara Co., the writer has been able to find, though very rarely, branchlets which had abnormally narrow subentire or entire leaves crowded beneath the heads, and which in every way matched the sort of branchlet which Nuttall described for *G. cuneifolia*. *Grindelia cuneifolia* Nutt. then proves to be merely an abnormal or rarely collected narrowly foliose shoot of *G. rubricaulis* var. *robusta*, and such shoots occur on otherwise typical plants. The writer has observed a similar case of this abnormal foliose condition in other varieties and forms of *G. rubricaulis*.

Likewise, Jones's *G. pacifica* is an abnormal or weakly developed plant having loosely spreading thin involucral bracts; this sort of growth may be found in young, weak, or abnormally developed small shoots of otherwise typical *G. rubricaulis* var. *robusta*, and is in no sense to be given valid taxonomic status.

**45. G. arenicola** Steyermark in Ann. Mo. Bot. Gard. **21**: 224. 1934.

*G. cuneifolia* Nutt. acc. to Peck in Am. Jour. Bot. **12**: 46. 1925.

Herbaceous perennial; stems prostrate, ascending to erect, 1 to several from a subligneous base, the base elongated and giving rise at the nodes to herbaceous shoots of the season, the floriferous branchlets loosely corymbosely branched above with divergent branchlets bearing few heads, or the branchlets elongated and simple and bearing only a single terminal head, stramineous or green to suffused with rose- or pink-purple, glabrous, 2–5 dm. tall; leaves firm to subcoriaceous, abundantly and rather conspicuously resinous-punctate, the main cauline sharply serrulate to dentate, often only above the middle, those on the floriferous branchlets frequently reduced, crowded, and entire, 1.2–8 cm. long, 0.2–3.5 cm. broad, 2½–5 times longer than broad, the radical or basal cuneate, broadly oblong-spatulate or obovate-cuneate, obtuse or subtruncate at apex, the others spatulate or oblong to (the uppermost) sometimes linear-lanceolate, obtuse to acute, conspicuously narrowed below the middle to sometimes (the upper) amplexicaul, glabrous; heads radiate, 2.5–4 cm. broad; disk campanulate-hemispherical, 0.8–1.2 cm. high, 1.2–2 cm. broad; involucre abundantly and conspicuously resinous, bracts 3.5–10 mm. long, lanceolate with rather elongated subulate tips, frequently merging into the leaves on the floriferous branchlets, the upper third to half with free loosely revolute or strongly reflexed tips, glabrous; rays 19–34, bright yellow or orange-yellow, the lamina 0.9–1.4 cm. long; achenes oblong, 3–4.5 mm. long, 1.3–1.5 mm. broad, smooth to slightly striate, obliquely auriculate, bordered at one angle, or appearing truncate at apex; awns mostly 3–5 to the floret, remotely to mostly moderately serrulate or setulose-serrulate, sometimes setulose, 3–4.5 mm. long, ⅔–¾ length of disk-floret.

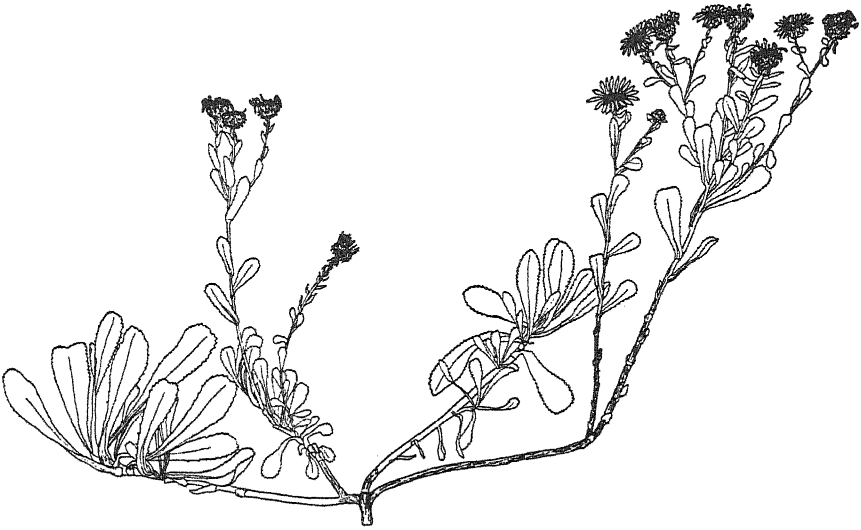

Fig. 38. *G. arenicola.* × ⅙.

Distribution: wet places in sand dunes, sand beaches, on sands on coastal mesas scattered along the coast from Coos Co., Oregon, south along the Californian coast to Carmel and Cypress Point, Monterey Co., and locally south on Santa Rosa Islands, Santa Barbara County.

Oregon: on beach at Bandon, Coos Co., Aug. 29, 1929, *Ferris 7806* (NY); sand dunes at Bandon, Coos Co., Aug. 14, 1928, *Gale 366* (G); moist sandy ground, mouth of Winchuck River, Curry Co., July 11, 1929, *Henderson 11419* (UO); margin of shore bluff, Bandon, July 31, 1919, *Peck 8992* (WI); seaward margin of coast bluff, The Heads, Port Orford, June 20, 1919, *Peck 9074* (WI).

CALIFORNIA: Fort Bragg, Mendocino Co., Aug. 8–16, 1912, *Eastwood 1592* (CAS, G, US); Fort Bragg, Mendocino Co., July 14–16, 1915, *A. S. Hitchcock* (US); 4 miles north of Crescent City, near beach, Aug. 9, 1923, *M. S. Baker 221b* (B); Cypress Point, Monterey, Nov. 9, 1912, *Eastwood 2424* (CAS); common in swale-like hollows in sand dunes, Mendocino Coastal plain, 4.5 miles north of Fort Bragg, Mendocino Co., Sept. 14, 1930, *J. T. Howell 5473* (CAL, CAS TYPE, G, M, PO); dunes, Carmel, Jan. 7–10, 1910, *Mrs. T. C. Pease* (G); open hillsides, Santa Rosa Island, April 9, 1930, *Hoffmann* (SB); along coast highway, between Pt. Arena and Anchor Bay, June 27, 1931, *M. S. Baker 5261* (B); along coast, Carmel-by-the-sea, March 27, 1910, *Randall 122* (ST); near beach, Carmel-by-the-sea, Feb. 13, 1910, *Randall 25* (ST); near lagoon, Crescent City, Del Norte Co., 1899, *Dudley* (ST).

### 45a. var. **pachyphylla** Steyermark, var. nov.[69]

Stems prostrate to ascending, the herbaceous shoots from a ligneous base or the shoots of the season developing from the older ligneous axes; leaves thick and coriaceous; reflexed or revolute tips of the involucral bracts thicker.

Distribution: open coastal plain and marine bluffs in Marin, San Mateo, Sonoma, and Mendocino Counties, California, and locally in southern Oregon.

OREGON: The Heads, Port Orford, Aug. 14, 1924, *Peck 13635* (WI).

CALIFORNIA: Moss Beach, San Mateo Co., July 15, 1917, *K. Brandegee* in part, as to specimen on left (PO); Bodega Point, Sonoma Co., Sept. 30, 1900, *Eastwood* (NY); open coastal plain, 6 miles south of Point Arena, Mendocino Co., Sept. 27, 1931, *J. T. Howell 8106* (CAS TYPE, G, M); marine bluff, 4 miles north of Bodega Bay, Sonoma Co., June 8, 1930, *J. T. Howell 5294* (CAS); sea-shore below Point Arenos, Mendocino Co., Aug. 8, 1901, *Congdon* (US); sand dunes, Pt. Reyes, Marin Co., Oct. 15, 1932, *Booth* (E); Point Reyes peninsula, June–July 1899, *Davy* (CAL); sea bluffs at Pescadero Beach, San Mateo Co., July 4, 1929, *Wiggins 3799* (CAL); Moss Beach, San Mateo Co., Oct. 26, 1924, *J. T. Howell 724* (CAS); Montara Point, San Mateo Co., June 7, 1903, *Copeland* (N, PO); sandy ocean bluffs, Montara, San Mateo Co., July 21, 1933, *Rose 33306* (CAS, M); San Francisco, Nov. 5, 1930, *Rose* (B); near Halfmoon Bay, sandy open hill near beach, coast road to Halfmoon Bay, San Mateo Co., June 22, 1922, *McMinn 252* (ST); suffrutescent on permanent dunes, Pt. Reyes peninsula (north shore), Marin Co., Nov. 5, 1933, *Ewan 8098* (E).

### 45b. f. **trichophora** Steyermark, f. nov.[70]

Stems villous or hirsute; leaves firm and subcoriaceous, closely or scarcely villous-puberulent to glabrate.

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[69] **Grindelia arenicola** var. pachyphylla Steyermark, var. nov., foliis crassis et coriaceis; bracteis involucri crassioribus.—Collected on open coastal plain, 6 mi. south of Point Arena, Mendocino Co., California, Sept. 27, 1931, *J. T. Howell 8106* (Cal. Acad. Sci. Herb. no. 188433 TYPE, G, M, isotypes).

[70] **Grindelia arenicola** f. **trichophora** Steyermark, f. nov., caulibus villosis vel hirsutis; foliis plerumque villoso-puberulis.—Collected at Halfmoon Bay, San Mateo Co., California, 1913, *W. F. Schmitt* (U. S. Nat. Herb. no. 880080 TYPE).

Distribution: along the coast of California, in Marin, San Mateo, and Mendocino Counties.

CALIFORNIA: Fort Bragg, July 12, 1931, *M. E. Jones 29141* (CAL, M); Granada, San Mateo Co., June 2, 1912, *Eastwood 216* (CAS, G); Halfmoon Bay, San Mateo Co., 1913, *Schmitt* (US TYPE); San Mateo Co., Aug. 6, 1915, *Drushel* (M); Moss Beach, San Mateo Co., July 15, 1917, *K. Brandegee* in part, as to specimen on right (PO); ocean bluffs near lighthouse, Point Reyes, Marin Co., April 19, 1927, *Abrams 11591, 11591a* (ST); common in fields surmounting ocean, Fort Bragg, Mendocino Co., July 6, 1920, *Duncan 165* (ST); coast, Pt. Reyes, Marin Co., April 19, 1927, *Chien P'ei 411* (B).

*Grindelia arenicola,* recently described, is quite typical of the sand dunes, sand beaches, and sands of the coastal mesa from southern Oregon south locally to San Mateo and Monterey Counties. The regularly serrate spatulate to oblanceolate-spatulate main lower and middle leaves of the species and varieties are broadly rounded at the apex, a character which serves to distinguish them from *G. stricta* var. *procumbens,* which has narrowly oblong or oblanceolate and acute lower and middle leaves. While *G. arenicola* and varieties and *G. stricta* var. *procumbens* have some of the stems procumbent and caespitose, those of *G. stricta* var. *procumbens* are nearly herbaceous throughout, while in *G. arenicola* and varieties the flowering stems mostly arise from elongated ligneous axes. In *G. stricta* var. *procumbens* the flowering stems curve upwards from an otherwise procumbent stem, while in *G. arenicola* and varieties the flowering shoots become more erect and ascending. Moreover, in *G. arenicola* and varieties the involucral bracts are strongly recurved or revolute, whereas in *G. stricta* var. *procumbens* they are more reflexed and squarrose and not revolute.

Within and at the margins of the range of *G. arenicola* and varieties several other entities occur, such as *G. stricta* and var. *procumbens* and *G. rubricaulis* var. *platyphylla.* Some collections have been taken which may represent hybrids between some of the entities mentioned above. For example, near the southern limit of dispersal of *G. arenicola,* near Carmel, Monterey Co., California, a region where *G. rubricaulis* var. *platyphylla* also occurs, we find collections, such as *J. T. Howell 11608,* which are intermediate between *G. arenicola* and *G. rubricaulis* var. *platyphylla*. Again, at places where *G. stricta* var. *procumbens* and *G. arenicola* approach each other within their ranges or near their limits, we encounter specimens somewhat intermediate between these two. Such a collection is that of *Applegate 5224* from bluffs along the seashore, Crescent City, Del Norte Co., Cal., collected June 20, 1926. At the northern limit of dispersal for *G. arenicola,* in southern Oregon, specimens are found intermediate between that species and *G. stricta* which occurs near this area (*Henderson 11454* from Hauser, Coos Co., *Henderson 11420* from Coos Bay, Coos Co., and others). A specimen, intermediate between the two forementioned species, of *Scullen* from top of sea-cliff, Shore-Acres, Coos Co., Oregon, collected July 18, 1926, may be of hybrid origin. Other collections taken in California which may be hybrids between *G. stricta* and *G. arenicola* are those of *Wolf 1319* from 3 miles north of Westport, Mendocino Co., and *Wolf 1214* from the Devil's Gate, south of Cape Mendocino, Humboldt Co.

## EXCLUDED SPECIES

*Donia canariensis* Less. Syn. Gen. Compos. 199. 1832 = Jasonia laevigata (Brouss.) DC.

*Donia ciliata* Nutt. in Jour. Acad. Nat. Sci. Phila. 2: 118. 1821 = Aplopappus ciliatus (Nutt.) DC.

*Donia lanceolata* Hook. Fl. Bor. Am. 2: 25. [1834] 1840 = Aplopappus lanceolatus (Hook.) Torr. & Gray.

*Donia uniflora* Hook. Fl. Bor. Am. 2: 25. [1834] 1840 = Aplopappus uniflorus (Hook.) Torr. & Gray.

*Grindelia pulchella* Bert. Merc. Chil. 643. 1829, not G. pulchella Dunal = Aplopappus pulchellus (Bert.) DC.

*Grindelia acerosa* Bert. Merc. Chil. 643. 1829 = Aplopappus integerrimus (Hook. & Arn.) Hall.

*Grindelia canescens* Bert. Merc. Chil. 643. 1829 = Aplopappus canescens (Phil.) Reiche.

*Grindelia glutinosa* Bert. Merc. Chil. 646. 1829, not G. glutinosa Dunal = Aplopappus chrysanthemifolius (Less.) DC.

*Grindelia incisa* Spreng. Syst. **3**: 575. 1826 = Aster incisus Fisch.

*Grindelia sibirica* Spreng. ex Link, Enum. Pl. Hort. Berol. **2**: 336. 1821. = Aster sibiricus L.

*Grindelia caucasica* Spreng. ex Steud. Nom. Bot. ed. 2. **1**: 707. 1841 = Aster caucasicus Willd.

*Grindelia coronopifolia* Lehm. Ind. Sem. Hort. Hamb. 16. 1828 = Xanthocephalum centauroides Willd.

*Grindelia stylosa* Eastw. in Proc. Cal. Acad. II. **6**: 293. 1896 = Vanclevea stylosa (Eastw.) Greene.

*Grindelia andina* (Phil.) Phil. in Linnaea **33**: 137. 1864 = Chrysophthalmum andinum Phil. in Linnaea **29**: 9. 1857. There is, however, an earlier published Chrysophthalmum Schz.-Bip. in Walp. Rep. **2**: 955. 1843.

## List of Exsiccatae

The distribution numbers are printed in *italics*. Unnumbered collections are indicated by a dash. The numbers in parentheses are the species numbers used in this revision.

Abbott, E. K. — (44); — (44h).

Abrams, L. R. *3957* (30); *6751, 7705* (31); *5393* (34); *6727* (34a); *12585* (34c); *9530* (35); *5751, 6889* (42c); *3903* (44b); *3072, 4105* (44d).

Abrams, L. R. & E. A. McGregor. *626* (12d).

Adams, J. Q. — (44d).

Aiton, G. B. — (12); — (13).

Ames, M. E. P. — (34d).

Anderson, A. P. — (12).

Anderson, W. B. — (13).

Anect, Bro. *12* (15).

Arsène, G. *5697, 5823* (1).

Arsène, G. & Bro. Abbon. *101* (7).

Atkinson — (42e).

Austin, R. M. *1953* (34d); *1614*, —, *572* (35c).

Babcock, E. B. & J. L. Collins. *84* (35); *52* (38).

Bailey, V. *256a* (8b).

Baker, C. F. — (12d); *702* (21); *683* (21a); *682* (23a); *47* (32); *2916* (34f); —, *687, 812* (42a).

Baker, H. P. — (12); — (12d); — (38).

Baker, M. S. — (35c); — (35e); *221b, 526* (45).

Baker, C. F., F. S. Earle & S. M. Tracy. *526* (15); *497, 600* (21a); *538* (23a).

Ballard, C. A. *2554* (12d).

Barber, J. H. — (44d); — (44i).

Bardell, E. M. — (39d).

Barham, A. R. — (13).

Basil, H. B. — (39).

Bates, J. M. —, *2592* (12).

Beard, A. — (24a).

Beckwith, F. *218* (19).

Beechey, F. W. — (42).

Berlandier, J. L. *766* (7); *647* (8); *541* (12b).

Bertrand, Bro. *80* (21a).

Bethel, E. — (17a).

Bethel, E., F. S. Willey & I. W. Clokey. *4321* (20a).

Bigelow, J. M. — (34e).

Binns, F. — (39d).

Bipontinus, S. — (37).

Bioletti, F. T. — (34) ; — (42d).
Blaisdell, F. E. — (34e).
Blake, S. F. *10328* (32) ; *10385* (37b) ; *10367* (39) ; *10368* (41) ; *9943, 9949* (42e) ; *9998, 10000, 10159* (43) ; *10154* (44h) ; *10157* (44i).
Blankinship, J. W. *267* (13) ; — (26) ; —(35d).
Blewitt, A. E. — (12d).
Blockman, Mrs. — (44f).
Bodin, J. E. — (12b).
Bolander, H. N. *2425* (32) ; *6493* (39a) ; *389* (42b) ; *89* (42d).
Booth, L. M. *2063* (32c) ; — (45a).
Bourgeau, M. *515* (1) ; — (13).
Brandegee, K. — (35c) ; — (44g) ; — (44h) ; — (44i) ; — (45a) ; — (45b).
Brandegee, T. S. — (15) ; *326* (17) ; — *906* (18) ; *1134, 4373* (23a) ; — (30) ; — (31) ; — (34) ; — (34d) ; — (35c) ; — (35e) ; — (42) ; — (44) ; — (44b) ; — (44e).
Braunton, E. *1007* (34d) ; *46, 117, 399* (44d).
Bray, W. L. *448* (12c).
Brewer, W. H. *850* (34) ; *1290* (34d) ; *657* (44).
Broadhead, G. C. — (13).
Brunet, J. — (35b).
Buffum, B. C. —, *398* (20) ; — (20a).
Bush, B. F. —, *4093* (12) ; *390* (12b) ; — (12c) ; *9174* (12d) ; *220* (26).
Butler, G. D. — (26) ; *499* (35e).
Cannon, E. — (34e).
Cannon, G. L. — (12d).
Carroll, J. A. — (12).
Carter, L. W. — (13).
Carter, W. K. — (39).
Carter, W. R. — (39i).
Chandler, B. F. — (12).
Chandler, H. P. *5460* (30) ; *7604* (34e) ; *326* (44i).
Chapline, W. R. *267* (24a).
Chestnut, V. K. *547* (35c).
Clark, J. A. *270* (35b).
Clarke, S. L. — (18).
Clemens, Mr. & Mrs. J. *948* (8b) ; *949* (25).
Clemens, M. S. — (37b).
Clements, F. E. & E. S. *243* (44b).
Cleveland, D. — (34d) ; — (44b).
Clokey, I. W. *2950, 3316* (12d) ; *4323, 4325* (17) ; *4324* (17a).
Clothier, G. L. & H. N. Whitford. *5459* (26).
Cockerell, T. D. A. — (19).
Cockerell, T. D. A. & W. P. — (19).
Coffman, C. F. — (12b).
Coleman, G. A. — (44).
Collins, G. N. & J. H. Kempton. *261* (35c).
Collins, J. F. — (12).
Commons, A. — (12).
Conard, H. S. *387* (39).
Condit, I. J. — (12) ; — (34d) ; — (42c).
Congdon, J. W. — (40) ; — (45a).
Conzatti, C. & V. Gonzalez. *388* (10).
Cooper, J. G. — (39i).
Copeland, E. B. *3884* (35c) ; — (45a).
Cory, V. L. *4896, 5013* (5) ; *4861, 5014* (12b) ; *4928* (12c) ; *26, 27* (24a).
Cottam, W. P. *2590* (12d).
Coville, F. V. *197* (26).
Coville, F. V. & F. Funston. *1116* (34b).
Coville, F. V. & J. B. Leiberg. *130* (35e).
Cowen, J. H. — (12d).
Cowles, H. C. *453* (39h).
Craig, M. — (12).
Crandall, C. S. — (12d).
Crawford, D. — (44d).
Cusick, W. C. *2058, 2185* (35) ; *505, 2058* (35f).
Daniels, F. *385, 845* (20a).
Davidson, A. *736* (23c).
Davis, J. *5780* (12).
Davis, R. J. — (35a).
Davy, J. B. — (33) ; *1383, 1385* (34e) ; — (42a) ; — (43) ; — (45a).
Davy, J. B. & W. C. Blasdale. *5957* (39).
Dawson, G. M. — (13) ; — (39) ; — (39d).
Deam, C. C. *36848* (12) ; *52901* (12d).
Deam, E. & A. J. Eames. *5096* (12d).
Demaree, D. *9235a, 10378* (44a) ; *10378* (44i).
Diehl, I. E. *150* (39g).
Douglas, D. *55* (44).
Dowell, P. *3050* (12).
Drummond, T. *131* (8b) ; *137* (26).

Drushel, J. A. *4165* (8b); — (17a); — (45b).
Dudley, W. R. *1343* (31); — (34e); — (44d); — (44h).
Dutton, D. L. — (12).
Duval, H. H. *307* (8b).
Earle, F. S. *36* (21a).
Earle, F. S. & E. S. *509, 571* (11).
Eastwood, A. *75* (12d); *63* (17a); *5934* (22); — (23a); — (32); *11049* (32a); — (34); — (34b); —, *1464, 3433* (34d); *3317* (34e); *11779* (39a); —, *9727* (39h); —, *280* (41); —, *322* (42a); — (42f); — (43); *4730* (44a); *13763* (44d); —, *396* (44e); *794* (44f); *13674, 14970* (44i); *1592, 2424* (45); *216* (45b).
Eastwood, S. — (12d).
Eccles, K. G. — (12).
Edwards, H. M. — (32a).
Eggert, H.— (5); — (12b); — (12c); — (26).
Eggleston, W. W. *12029* (17a); *5946* (21a); *19587* (44e).
Ellis, C. C. *85* (15).
Elmer, A. D. E. *498* (12d); *4621* (39a); *4065* (44h).
Elrod, M. J. & assistants. — (35a).
Emig, W. H. *811* (25); *45* (26).
Engelmann, G. — (12); — (15); — (32); — (39).
Engelmann, H. — (12); — (12d); — (13); — (20a).
Epling, C. & M. Houck. *10032* (12d).
Evans, A. *387* (35).
Ewan, J. *8098* (45a).
Farwell, O. A. *7195* (12d).
Fendler, A. *390* (15).
Ferris, R. S. *828* (34e); *7806* (45).
Ferris, R. S. & C. D. Duncan. 3391 (12c); *3538* (19).
Ferris, R. S. & R. Duthie. *1269* (35).
Feudge, J. B. *1813* (44d).
Fieldstad, H. L. — (13).
Fisher, G. L. — (14b); *119, 265, 629, 5156* (27).
Fitzpatrick, T. J. et al. — (12).
Forbes, C. N. — (34a).
Foster, A. S. *831* (39).
Fowler, J. — (12d).
Freiberg, G. W. — (39d).
Fritchey, J. Q. A. *165* (19a).
Frye, T. C. — (39d).
Gale, N. P. *366* (45).
Gardner, N. S. — (39g).
Garrett, A. O. *2200* (12); *5380, 6462* (35a).
Gattinger, A. — (26).
Gay, J. — (37).
Gilbert, H. C. *132, 474* (37).
Gilkey, H. *79* (37).
Gleason, H. A. — (12d).
Gorman, M. W. — (37b); — (39).
Gotfredson, A. *95* (35).
Gough, L. O. — (12b).
Grant, J. M. — (39d); — (39i).
Graves, E. W. *2237* (20).
Greene, E. L. — (16); — (17); *15 & 16* (18); — (20); — (21); — (32a); — (33); — (34); *974* (35e); — (37b); — (42a); — (42c); — (43); — (44e).
Greenman, J. M. & M. T. *6032* (20).
Gregg, J. *444, 627* (14); *97, 233, 354* (14b).
Griffiths, D. *6302* (8a); — (12d).
Griffiths, D. & B. Hunter. — (35).
Grimes, E. J. *4265* (12).
Grinnell, F. *412* (34b).
Groth, B. H. A. *198* (8b).
Guttenberg, G. — (12d).
Haenke, T. — (39).
Hall, E. —, *264* (37); *266* (37c); *268* (38); *265* (39); — (39a).
Hall, H. M. *5720* (32a); *6719* (34b); *3302* (34d); *11996* (37b); *3175, 7712* (44d).
Hannibal, E. — (34d).
Hansen, G. *172, 1672* (34e).
Hanson, A. — (12).
Hanson, H. C. *C127* (20a).
Hardwick, E. J. — (12).
Harford, W. G. W. — (44e).
Harford, W. G. W. & G. W. Dunn. — (38).
Harper, E. T. & S. A. — (17a); — (18).
Harris, B. B. *110* (12c).

Harris, T. — (39d).
Harrison, G. J., T. H. Kearney & H. J. Fulton. *8334* (23).
Hart, E. — (31).
Hartweg, T. *1786* (44i).
Harvey, F. L. *48* (26).
Hasse, H. E. — (44b).
Hatcher, J. B. — (12).
Havard, V. *63* (11); *81* (12b); — (15).
Havens, M. — (39d).
Hayden, F. V. — (12).
Haydon, W. *37* (39).
Hayward, H. E. *2013* (12).
Hedgcock, G. G. — (16).
Heller, A. A. *1820* (8); *10639*, *14315* (12d); *7542* (33c); *5810*, *8117*, *10780* (34d); *14557*, *11351* (34e); *12979* (35e); *13870* (41); *6843* (44h); — (44i).
Heller, A. A. & H. E. Brown. *5578* (34d); *5578* (34e).
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Annals
of the
Missouri Botanical Garden

Vol. 21 NOVEMBER, 1934 No. 4

# TWO NEW ASCLEPIADS FROM SZECHUAN, CHINA[1]

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**Tylophora minutiflora** Woodson, sp. nov., fruticosa volubilis altitudine ignota; ramulis teretibus juventate sparse puberulis mox glabratis maturitate cortice brunneis inconspicue lenticellatis; foliis oppositis petiolatis elliptico-lanceolatis apice acutis acuminatisve basi obtusis 3.0–4.5 cm. longis 0.7–1.8 cm. latis membranaceis post exsiccationem inconspicue bullatis caeterumque glabris; petiolis 0.3–0.5 cm. longis glabris; inflorescentiis lateralibus cymosis foliis multo brevioribus pauci-floris; pedunculo petiolos duplo vel triplo superante sparse minutissimeque puberulo; pedicellis 0.25–0.3 cm. longis ut in pedunculo vestitis; bracteis lanceolatis ca. 0.1 cm. longis; calycis laciniis ovatis fere obtusis 0.15 cm. longis extus minute pilosulis intus basi in marginibus squamellas 4–5 gerentibus; corollae rotatae luteo-viridis extus intusque glabrae tubo vix manifesto basi ca. 0.075 cm. diametro metiente, lobis ovatis obtusis cum tubo ca. 0.35 cm. longis patulis; gynostegio ca. 0.18 cm. longo; antheris oblongo-sagittatis anguste obscurissimeque auriculatis apice obtusis hyalinis ca. 0.11 cm. longis coronae segmentum unciforme ca. 0.025 cm. longum leviter inflexum dorso ad insertionem filamenti quoque gerentibus; pollinibus ovoideis minutissime polyconvexis ca. 0.01 cm. longis; caudiculis brevissimis; retinaculo compresse obovoideo-sagittato

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[1] Issued December 12, 1934.

vix 0.01 cm. aequante; ovario glabro ca. 0.1 cm. alto; stigmate obovoideo inconspicue bullato apice paululo bipartito ca. 0.07 cm. longo extra antheras conspicuissime exserto viridulo; folliculis ignotis.—China: szechuan: O-pien Hsien, alt. 900 m., mountain slope along roadside, May 15, 1932, *T. T. Yü 745* (Herb. Arnold Arboretum, type, Herb. Missouri Bot. Garden, analytical drawings).

The inflorescence of this species recalls that of *T. fasciculata* Ham. in general construction, but the flowers of the latter are somewhat larger, the corona segments globular, and the stigma, although exserted beyond the anther-tips, does not attain such extreme development. Apparently *T. minutiflora* is most closely allied to *T. pseudotenerrima* Pitard, of French Indo-China, which I know only from the rather meagre original diagnosis. The latter species seems to differ in having linear or linear-lanceolate leaves 4.0–9.5 cm. long and only 0.5–1.1 cm. broad with a distinct marginal vein, while the calyx-lobes are described as acute, and the corolla as pubescent within. The description of the corona segments pronounces them "gibbous," as in *T. minutiflora*, but relative dimensions are not given. The stigma of *T. pseudotenerrima* has not been de-

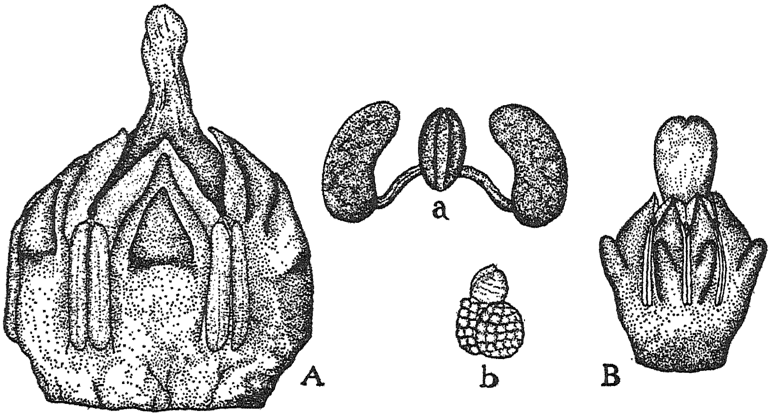

Fig. 1. A, gynostegium (x 8½), and a, pollinia (x 30), of *Marsdenia carnea* Woods.; B, gynostegium (x 20), and b, pollinia (x 92), of *Tylophora minutiflora* Woods.

scribed, and the aspect and dimensions of the other components of the gynostegium, including the pollinia, likewise have been neglected.

**Marsdenia carnea** Woodson, sp. nov., suffruticosa volubilis altitudine ignota; ramulis teretibus post exsiccationem longitudinaliter striatis juventate leviter pilosulis maturitate glabratis cortice olivaceis; foliis oppositis longiuscule petiolatis ellipticis apice fere subcaudato-acuminatis basi acutis saepe fere attenuatis 6–12 cm. longis 1.5–4.0 cm. latis coriaceis post exsiccationem olivaceis supra juventate sparse pilosulis maturitate glabratis nervo medio venisque minute scaberulis subtus minutissime velutino-papillatis; petiolis 1.5–2.0 cm. longis minute puberulis; inflorescentiis lateralibus alternatis umbellato-cymosis paucifloris; pedunculo leviter puberulo petiolos paulo superante; pedicellis 0.9–1.0 cm. longis ut in pedunculo vestitis; calycis laciniis late ovatis obtusis 0.2–0.25 cm. longis extus pilosulis intus basi squamellam parvam gerentibus; corollae urceolato-campanulatae carneae tubo 0.7 cm. longo basi ca. 0.5 cm. diametro metiente extus glabro intus minute puberulo; lobis late ovatis obtusis rotundatisve ca. 0.2 cm. longis leviter recurvatis; gynostegio ca. 0.6 cm. longo; antheris late oblongo-sagittatis apice anguste acutis ca. 0.3 cm. longis dorso paululo supra medium coronae segmentum triangulare acuminatum ca. 0.07 cm. longum quoque gerentibus; pollinibus oblongoideo-reniformibus leviter inflexis ca. 0.05 cm. longis; caudiculis pollinia subaequantibus; retinaculo late oblongo-sagittato ca. 0.02 cm. longo; ovario glabro ca. 0.1 cm. longo; stigmate conico apice anguste obtuso inconspicue bipartito conspicue exserto antheras ca. bis superante; folliculis ignotis.—CHINA: SZECHUAN: twining on shrub, Mt. Omei, alt. 1770 m., July 9, 1931, *F. T. Wang 23275* (Herb. Missouri Bot. Garden, TYPE).

Closely related to *M. Calesiana* Wight, which is characterized by cordate foliage, much-branched cymes, and corollas which are pubescent externally.

# NEW OR OTHERWISE NOTEWORTHY APOCYNACEAE OF TROPICAL AMERICA. IV[1]

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**Temnadenia stenantha** Woodson, sp. nov., fruticosa volubilis altitudine ignota; ramulis crassiusculis juventate minute ferrugineo-tomentulosis maturitate glabratis et inconspicue lenticellatis; foliis oppositis longe petiolatis oblongo-ellipticis apice breviter acuminatis basi late obtusis 11–13 cm. longis 4.5–5.0 cm. latis rigide membranaceis subcoriaceisve supra glabris subtus basi inconspicue minuteque puberulis caeterumque glabris; petiolis 1.7–1.9 cm. longis minute ferrugineo-puberulis; inflorescentiis lateralibus alternatis trichotome bostrycino-racemosis foliis paulo brevioribus vel subaequantibus floras 20–25 mediocres fulvas gerentibus; pedunculo di-trichotomo minute irregulariterque ferrugineo-tomentuloso; pedicellis 1.0–1.25 cm. longis post maturitatem paulo accrescentibus minute ferrugineo-puberulis; bracteis minute lanceolatis acuminatis 0.1–0.3 cm. longis paululo foliaceis; calycis laciniis ovato-lanceolatis acutis acuminatisve prope basem connatis 0.35–0.525 cm. longis plus minusve foliaceis extus minute ferrugineque puberulo-papillatis intus glabris squamellam obscure bifidem basi gerentibus; corollae salverformis tubo 2.5–2.7 cm. longo basi ca. 0.2–0.25 cm. diametro metiente prope apicem paululo gradatim dilatato extus minute ferrugineque puberulo-papillato intus prope insertionem staminum minute villosulo caeterumque glabro lobis oblique obovato-oblongis rotundatis ascendentibus 1.0–1.1 cm. longis; antheris omnino inclusis elliptico-sagittatis acuminatis auriculis angustissimis 0.7–0.75 cm. longis dorso dense villosulo-barbatis; ovario oblongoideo apocarpo ca. 0.15 cm. longo omnino glaberrimo; stigmate fusiformi-subcapitato apice obscure obtuseque bipartito ca. 0.15 cm. longo; nectariis com-

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[1] Issued December 12, 1934.

presse oblongoideis ovarium paululo superantibus haud connatis; folliculis ignotis.—COLOMBIA: BOYACA: on edge of high forest, region of Mt. Chapon, alt. 7000 ft., June 17, 1932, *A. E. Lawrance 241* (Herb. New York Bot. Garden, TYPE, Herb. Missouri Bot. Garden, photograph and analytical drawings).

At first sight this plant was mistaken for a species of *Laubertia*, which it simulates superficially, particularly with regard to the mode of inflorescence, the shape of the corolla, and the minute ferruginous indument. The floral characters indicate an alliance with the technical requirements of *Temnadenia* which it is impossible to disregard.

Mr. Lawrance observes that this species is rare where found, in the mountainous region of extreme western Boyaca, at a distance of about one hundred miles northwest of Bogota. The flowers are reported as "bright yellow" and without odor. The vine is described by Lawrance as creeping upon the ground.

**Macropharynx anomala** Woodson, sp. nov., fruticosa volubilis altitudine ignota; ramulis crassiusculis minute denseque ferrugineo-tomentulosis tandem glabratis; foliis oppositis petiolatis late ovatis apice anguste breviterque subcaudato-acuminatis basi late obtusis vel rotundatis saepe subcordatis 10–18 cm. longis 5–9 cm. latis membranaceis supra irregulariter ferrugineque puberulo-papillatis subtus dense minutissimeque ferrugineo-tomentulosis; petiolis 2.5–3.0 cm. longis minute ferrugineo-tomentulosis; inflorescentiis lateralibus oppositis subumbellato-fasciculatis e cyma bostrycina 3-chotoma aperte derivatis paucifloris; pedunculis 1.0–2.5 cm. longis minute ferrugineo-tomentulosis pluribracteatis; bracteis linearibus 1.0–1.4 cm. longis minute pilosulis puberulo-papillatisve; pedicellis 0.15–0.23 cm. longis ut in pedunculo vestitis; calycis laciniis anguste elliptico-lanceolatis acuminatis 1.7–1.8 cm. longis foliaceis minutissime puberulo-papillatis intus basi squamellam deltoideam minute denticulatam gerentibus; corollae salverformis colore ignotae tubo (in alabastro) 1.4–1.6 cm. longo basi ca. 0.25 cm. diametro metiente prope insertionem staminum paulo inflato deinde prope orificem gradatim angustato extus intusque minute puberulo-papillato lobis anguste ovato-dolabriformibus acuminatis 0.9–1.0 cm. longis; staminibus prope basem corollae insertis; antheris anguste sagittatis auriculis breviusculis acuminatis 0.7–0.72 cm. longis dorso minutissime papillatis glabratisve; ovario oblongoideo ca. 0.15 cm. longo glabro; stigmate subcapitato 0.15 cm. longo; nectariis compresse ovoideo-oblongoideis ovarium paulo superantibus; folliculis ignotis.—ECUADOR: in silv. tropic. fl. Pilaton, Oct., 1902, *A. Sodiro 107/16* (Herb. Berol., TYPE, Herb. Missouri Bot. Garden, photograph and analytical drawings).

The relegation of this species to *Macropharynx* is not completely without question. In aspect and position of the inflorescence, the single specimen resembles *Macropharynx spectabilis* (Stadelm.) Woodson, of which it is viewed tentatively as a congener. On the other hand, the inflorescences of *M. anomala* appear to have been derived from di- or trichotomous bostrychoid racemes such as occur in the typical species of *Temnadenia* having undergone great reduction. The pentamerous calyx and non-bracteate pedicels present arguments against the inclusion of the species within the monotypic *Macropharynx.*

**Echites turbinata** Woodson, sp. nov., fruticosa volubilis altitudine ignota; ramulis crassiusculis glabris maturitate conspicue lenticellatis; foliis oppositis petiolatis ellipticis apice acuminatis basi late obtusis 7.5–12.0 cm. longis 3.5–7.0 cm. latis firme membranaceis aperte paulo subsucculentis pallide viridibus omnino glabris; petiolis 0.8–1.3 cm. longis; stipulis intrapetiolaribus deltoideis subintegris; inflorescentiis lateralibus alternatis folia subaequantibus floras mediocres 8–10 gerentibus; pedunculo glabro; pedicellis 0.8–1.0 cm. longis glabris; bracteis ovato-lanceolatis 0.15–0.3 cm. longis; calycis laciniis ovatis longe acuminatis 0.3–0.32 cm. longis paulo foliaceis glabris intus basi squamellam deltoideam minutissime denticulatam gerentibus; corollae salverformis (colore ut creditur aut albidae aut gilvae) tubo 0.7 cm. longo basi ca. 0.15 cm. diametro metiente prope orificem paulo angustato extus intusque minute puberulo-papillato lobis anguste elliptico-lanceolatis acuminatis 1.4–1.6 cm. longis turbinatis; antheris paululo exsertis anguste sagittatis 0.45 cm. longis glabris; stigmate fusiformi-subcapitato; ovario ovoideo minutissime pilosulo-papillato ca. 0.15 cm. longo; nectariis compresse oblongoideis ovario paulo brevioribus prope apicem inconspicue pilosulis; folliculis ignotis.—COSTA RICA: forets du Rancho Flores, Febr. 22, 1890, *A. Tonduz 2147* (Herb. Berol., TYPE, Herb. Missouri Bot. Garden, photograph and analytical drawings).

This species is most closely related to *E. Tuxtlensis* Standl., as is evidenced by the dichasial inflorescence, narrow corolla-lobes, and general aspect of the subsucculent foliage. The latter species differs, however, in the smaller corolla and leaves, and in the more ramified, more diffuse inflorescence with more slender branches. The type specimen of *E. turbinata* is of interest morphologically, since it indicates a transition from trichasial to dichasial mode of inflorescence in the upper branches. The same species is apparently represented by *Ørsted 15544* "in Monte Barba," Costa Rica, in the herbarium at Copenhagen.

**Echites cincinnalis** Woodson, sp. nov., suffruticosa volubilis altitudine ignota; ramulis graciliusculis minutissime sparsissimeque pilosulis; foliis oppositis breviter petiolatis ovato-ellipticis apice breviter acuminatis basi obscure cordatis vel latissime obtusis 4.5–8.0 cm. longis 2.0–4.5 cm. latis membranaceis utrinque glabris opacis dilute viridibus; petiolis 1.0–1.5 cm. longis; stipulis intrapetiolaribus haud visis; inflorescentiis lateralibus alternatis cincinnalibus simplicibus floras speciosas 8–14 gerentibus; pedunculo folios subaequante ut in ramulo vestito; pedicellis 0.8–0.9 cm. longis minutissime pilosulis; bracteis minute lanceolatis ca. 0.1 cm. longis caducis; calycis laciniis anguste lanceolatis paululo foliaceis 0.3–0.35 cm. longis acuminatis minute sparseque pilosulis intus basi squamellam deltoideo-ligulatam subintegram gerentibus; corollae salverformis tubo 3.5–3.75 cm. longo basi ca. 0.15 cm. diametro metiente usque ⅓ altitudinem angustato deinde abrupte dilatato ibique staminigero deinde prope fauces gradatim angustato non contorto lobis oblique obovatis 1.8–2.0 cm. longis patulis margine sparse pilosulo-ciliatis; antheris ovato-lanceolatis acuminatis 0.75 cm. longis glabris omnino inclusis; stigmate fusiformi-subcapitato ca. 0.175 cm. longo; ovario oblongoideo ca. 0.15 cm. longo glabro; nectariis compresse obovoideis apice paululo emarginatis plus minusve connatis ovario ca. dimidio brevioribus; folliculis ignotis.—NICARAGUA: GRANADA: environs de Granada, alt. 40 m., autumn, 1869, *P. Lévy 1074* (Herb. Copenhagen, TYPE, Herb. Missouri Bot. Garden, photograph and analytical drawings).

This species is unique in the genus *Echites* because of its simple, cincinnal inflorescence, resembling that of the genus *Fernaldia*, and its inconspicuous indument. Its closest known relatives are apparently *E. turrigera* Woods., *E. elegantula* Woods., and *E. yucatanensis* Millsp.

**Cufodontia arborea** Woodson, sp. nov., arbor magna altitudine ignota; ramulis teretibus juventate plus minusve puberulis mox glabratis conspicue lenticellatis rimosis; foliis alternatis petiolatis late oblongo-ellipticis apice obtusis vel late acutis basi late obtusis 8.0–12.5 cm. longis 2.5–4.5 cm. latis subcoriaceis omnino glabris supra nitidulis subtus opacis venis secundariis subhorizontalibus utroque latere ca. 15–18; petiolis 1.0–1.2 cm. longis canaliculatis juventate ut in ramulo vestitis mox glabratis; cymis extra-axillaribus alternatis 7–9-floris dichotome divisis; pedunculo petiolos subaequante minute puberulo; pedicellis 0.35–0.4 cm. longis minute puberulis; tubo calycis cylindrico prope orificem paululo dilatato 0.6 cm. longo obtuse breviterque 2-labiato extus minute puberulo-papillato laciniis interioribus ovato-reniformibus obtusis apice minutissime acuminatis ciliatis; corollae dilute fulvae tubo cylindrico ca. 0.6–0.625 cm. longo basi ca. 0.175 cm. diametro metiente extus prope orificem puberulo-papillato intus villosulo lobis oblique oblongo-ellipticis acutis 0.9–0.95 cm. longis prope basem minute villosulis patulis; staminibus prope medium tubi corollae insertis filamentis ca. 0.05 cm. longis antheris ovoideis acuminatis ca. 0.15 cm. longis glabris omnino inclusis; ovariis ovoideis apocarpis ca. 0.1 cm. longis glabris; stylo ca. 0.2–0.225

cm. longo; stigmate cylindrico-subcapitato ca. 0.05 cm. longo; fructibus desiderantibus.—MEXICO: OAXACA: vicinity of Cafetal Concordia, alt. 400–650 m., April 1–15, 1933, *C. V. Morton & E. Makrinius 2692* (U. S. Nat. Herb., TYPE, photograph and analytical drawings, Herb. Missouri Bot. Garden).

The status of this peculiar genus is somewhat enlightened by Mr. Morton's collecting notes, which describe the plant as a "large tree with milky sap; corolla pale yellow." The other species of *Cufodontia*, *C. Stegomeris* and *C. Lundelliana*, have been classified by the collectors of the type specimen of either as shrubs. From both, *C. arborea* differs in the larger leaves and corolla. The corolla is puberulent without as in *C. Stegomeris.* Fruit is unknown for all three species.

**Forsteronia portoricensis** Woodson, sp. nov., fruticosa volubilis; ramulis sat crassiusculis glaberrimis vel juventate minutissime papillatis maturitate inconspicue lenticellatis; foliis oppositis breviter petiolatis oblongo-ellipticis rariusve ovalibus apice abrupte brevissime acuminatis non raro aut acutis aut obtusis basi late obtusis 3.2–9.0 cm. longis 1.3–4.7 cm. latis coriaceis margine post exsiccationem paululo revolutis venis secundariis arcuatis sat sparsis glaberrimis supra nitidulis subtus pallidioribus; petiolis 0.4–0.6 cm. longis; inflorescentiis corymboso-paniculatis terminalibus folia subaequantibus vel plus minusve manifeste brevioribus floras multas parvas coccineas rariusve carneas gerentibus; pedunculo minute puberulo-papillato vel glabriusculo; pedicellis 0.2–0.3 cm. longis papillatis rariusve minute sparseque puberulo-papillatis; bracteis ovatis 0.1–0.25 cm. longis scariaceis; calycis laciniis ovatis acutis vel obtusis 0.18–0.3 cm. longis scariaceis extus papillatis glabriusculisve squamellis alternatis 2–4; corollae tubo 0.15–0.2 cm. longo basi ca. 0.12–0.15 cm. diametro metiente faucibus ca. 0.18–0.2 cm. diametro metientibus extus glabris intus glabris vel indistinctissime papillatis lobis oblongo-ligulatis obtusis 0.4–0.5 cm. longis patulis extus intusque glabris margine non raro minute sparseque ciliolatis; filamentis staminum 0.3–0.32 cm. longis stylo agglutinatis antheris 0.25–0.3 cm. longis omnino exsertis glabris; ovario apocarpo ovoideo

ca. 0.07 cm. longo minute puberulo non raro glabriusculo; stigmate 0.1–0.13 cm. longo; stylo 0.25–0.3 cm. longo; nectariis ovarium subaequantibus; folliculis sat gracilibus flexuosis acuminatis reflexo-divaricatis plus minusve obfalcatis 14–19 cm. longis glabris; seminibus 0.9–1.0 cm. longis como dilute aurantiaco 1.8–2.0 cm. longo.—PORTO RICO: prope Humaco in fruticetis litoralibus ad "Candelero," Sept. 29, 1886, *P. Sintenis 5195* (Herb. Berol., TYPE, Herb. Missouri Bot. Garden, photograph and analytical drawings).

Apparently all specimens from Porto Rico previously determined as *F. corymbosa* (Jacq.) G. F. W. Meyer are referable to this species. *F. corymbosa, F. floribunda* (Sw.) G. F. W. Meyer, and *F. portoricensis* form a closely knit complex within the genus *Forsteronia.* Each is strictly endemic to a single island or island group of the Greater Antilles. A summary of the principal differences and similarities of the three species may conveniently be provided in parallel columns:

| *F. corymbosa* | *F. portoricensis* | *F. floribunda* |
|---|---|---|
| *Leaves* obovate to broadly oval; *venation* broadly arcuate, relatively distant. | *Leaves* oblong-elliptic, rarely oval; *venation* broadly arcuate, relatively distant. | *Leaves* oblong-elliptic to oval; *venation* subhorizontal, dense. |
| *Corolla* deep red, rarely pale flesh-colored; *lobes* papillate within. | *Corolla* deep red; *lobes* glabrous within. | *Corolla* greenish-white; *lobes* glabrous within. |
| *Follicles* horizontal, stout, blunt, 11–14 cm. long. | *Follicles* reflexed-divaricate, more or less obfalcate, acuminate, 14–19 cm. long. | *Follicles* subparallel to tortuous or divaricate, flexuose, acuminate, 16–30 cm. long. |
| *Plants* of Cuba and Hispaniola. | *Plants* of Porto Rico. | *Plants* of Jamaica. |

It is not always recognized by taxonomists that overlapping distinctions or criteria among species are biologically significant or worthy of note other than for the purposes of intended reduction to synonymy. The fact that related species are plexi of similar and dissimilar characters has consequently been much neglected in the search for "diagnostic" characters for the bare purpose of easy identification. Therefore the position has been taken that, in spite of recognition that the characters enumerated above for *F. corymbosa, F. portoricensis,* and *F. floribunda* show a definite tendency of progression, or intergradation, from *F. corymbosa* to *F. floribunda,* or vice versa, through *F. portoricensis,* evidence is not thereby provided for the maintenance of one, rather than of three species. Nor does the existence of *F. portoricensis* impair the interpretation of *F. corymbosa* and *F. floribunda* as important biological entities. It may be argued with reason that geographical isolation has been responsible for the crystallization of the plexus into three closely related but patently distinct entities rather than into one rather loose and variable, larger group. Such is probably the case. At any event, is it not more than possible that the scrutiny of the relationships of such closely related botanical entities may contribute much to our understanding of the functions of organic evolution?

**Forsteronia paludosa** Woodson, sp. nov., suffruticosa volubilis; ramulis sat gracilibus glabris maturitate conspicue lenticellatis; foliis oppositis brevissime petiolatis anguste oblongolanceolatis breviter acuminatis vel acutis basi obtusis 5–7 cm. longis 1.3–1.6 cm. latis firmiter membranaceis vel subcoriaceis supra glabris nervo medio basi pauciglanduligero subtus in axillis nervi medii inconspicue barbellatis caeterumque glabris; petiolis 0.25–0.3 cm. longis glabris; inflorescentiis subspiciformi-paniculatis terminalibus folia subaequantibus floras plures parvas albidas gerentibus; pedunculo primario glabriusculo superne sparsissime irregulariterque pilosulo-papillato ultimo vix manifesto; pedicellis ca. 0.01–0.02 cm. longis minutissime puberulo-papillatis; bracteis minute ovatis 0.01–0.03 cm. longis scariaceis; calycis laciniis ovatis acutis 0.1–0.12 cm. longis minutissime puberulo-papillatis scariaceis eglanduligeris; corollae extus minutissime irregulariterque puberulo-papillatae tubo 0.1–0.12 cm. longo basi ca. 0.075 cm. diametro metiente faucibus ca. 0.125 cm. diametro metientibus intus minute villosulo lobis oblongis ca. 0.15 cm. longis intus

dense pilosulis patulis; filamentis staminalibus ca. 0.05 cm. longis distinctis stylo haud agglutinatis antheris subinclusis apice parum exsertis ca. 0.15 cm. longis minute barbellatis; ovario ovoideo apocarpo ca. 0.05 cm. longo minute papillato; stigmate ca. 0.12 cm. longo; nectariis ovario brevioribus; folliculis ignotis.—BRAZIL: PARA: locis paludosis, Campos de Cupijo, prope Cometa, July 22, 1916, *A. Ducke 21627* (Herb. Berol., TYPE, Herb. Missouri Bot. Garden, photograph and analytical drawings).

Well distinguished by its small, narrow foliage and subspiciform inflorescence. The eglandular calyx is a rarity in the genus.

**Forsteronia simulans** Woodson, sp. nov., fruticosa volubilis; ramulis sat crassiusculis glaberrimis maturitate inconspicue lenticellatis; foliis oppositis breviter petiolatis oblongo-ellipticis apice acutis basi obtusis vel plus minusve cuneatis 2–5 cm. longis 0.7–2.2 cm. latis coriaceis vel subcoriaceis omnino glaberrimis supra nervo medio pauciglanduligero subtus pallidioribus venis secundariis subhorizontalibus; petiolis 0.3–0.5 cm. longis; inflorescentiis dense corymboso-subumbellatis simplicibus (vel obscurissime compositis?) terminalibus folia subaequantibus floras numerosas virido-fulvidas gerentibus; pedunculo minute papillato; pedicellis 0.5–0.6 cm. longis minutissime papillatis; bracteis ovato-lanceolatis 0.15–0.3 cm. longis paululo foliaceis; calycis laciniis ovatis obtusis 0.15–0.2 cm. longis extus glabriusculis vel minutissime papillatis squamellis alternatis solitariis; corollae tubo ca. 0.25 cm. longo basi ca. 0.125 cm. diametro metiente faucibus ca. 0.15 cm. diametro metientibus extus glabro intus minute puberulo lobis ovatis obtusis ca. 0.2 cm. longis patulis extus intusque glabris margine minute sparseque ciliolatis; filamentis staminum ca. 0.15 cm. longis stylo agglutinatis antheris ca. 0.2 cm. longis omnino exsertis glabris; ovario apocarpo ovoideo ca. 0.06 cm. longo glabro; stigmate ca. 0.2 cm. longo; stylo ca. 0.2 cm. longo; nectariis ovarium subaequantibus; folliculis ignotis.—COLOMBIA: SANTANDER DEL NORTE: eastern slope of Paramo del Hatico, en route from Toledo to Pamplona, alt. 2300 m., edge

of woods, March 12, 1927, *E. P. Killip & A. C. Smith 20568* (U. S. Nat. Herb., TYPE, Herb. Missouri Bot. Garden, photograph and analytical drawings).

It is astonishing to find a plant as similar superficially as this plant is to *F. floribunda* of Jamaica, with as many striking morphological dissimilarities. The foliage of the two species appears strikingly similar with regard to general size and shape, texture, color, and venation. However, that of *F. simulans* is glandular at the base of the midrib, while that of *F. floribunda* is eglandular. The general aspect of the inflorescence of the species is also somewhat similar, and the color of the flowers is generally alike. But the inflorescence of *F. simulans* is evidently simple, or appears so upon dissection; that of *F. floribunda* is thyrsiform. That the evidently simple inflorescence of the former represents a reduction from a previous compound state appears plausible. One of the most striking characteristics of *F. simulans,* however, is found in the stigma, which is virtually umbraculiform as in the genus *Mandevilla,* which it resembles in this character more nearly than the other species of *Forsteronia* with relatively simple, fusiform or subcapitate stigmata. The species, in short, appears to be of unusual phylogenetic interest.

**Forsteronia Velloziana** (A. DC.) Woodson, comb. nov.

*Echites bracteata* Vell. Fl. Flum. 112. 1830; Icon. **3**: *pl. 41.* 1827, not HBK.

*Echites Velloziana* A. DC. in DC. Prodr. **8**: 474. 1844.

*Forsteronia multinervia* A. DC. γ. *microphylla* Muell.-Arg. in Mart. Fl. Bras. **6**$^1$: 105. 1860.

*Forsteronia ? bracteata* (Vell.) Muell.-Arg. loc. cit. 106. 1860.

*Thyrsanthus bracteatus* (Vell.) Miers, Apoc. So. Am. 102. 1878.

*Forsteronia microphylla* (Muell.-Arg.) Hand.-Mzt. Denkschr. Akad. Wiss. Wien **79**: 388. 1931 (reprint, 12. 1910).

An unmistakable and rather frequently collected element of the southern Brazilian flora. There can be little question that this entity is entitled to full specific rank. Its brushy, subcorymbose inflorescence, virtually erect corolla-lobes, vegetative indument, and short, rigid follicles are quite uniform throughout a wide series of specimens examined during the course of a revision of *Forsteronia* in manuscript.

**Prestonia Meg'agros** (Vell.) Woodson, comb. nov.

*Echites Meg'agros* Vell. Fl. Flum. 110. 1830; Icon. **3**: *pl. 33*. 1827.

*Haemadictyon megalagrion* Muell.-Arg. in Mart. Fl. Bras. **6**$^1$: 170. 1860.

*Prestonia megalagrion* (Muell.-Arg.) Miers, Apoc. So. Am. 149. 1878.

It appears necessary to restore the original spelling of this species, illegitimately altered by Mueller.

# HYMENOGASTER AND RELATED GENERA[1]

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In continuation of our studies on the Hymenogasteraceae *(sensu latiore)* we here present the genera belonging to that family in the restricted sense used by Dodge[2]: *Hymenogaster, Richoniella, Dendrogaster,* and *Gautieria. Dendrogaster* and *Gautieria* seem closely related to *Hymenogaster,* although often placed in the Hysterangiaceae on account of the greater development of sterile tissues (columella) in the gleba. In separating these genera, spore characters have been given precedence over the presence or absence of peridium, *Gautieria* being restricted to species with conspicuously striate or longitudinally ribbed spores and *Dendrogaster* to those with a well-developed columella and some species also with a very highly developed utricle. *Dendrogaster* may be separated from the species of *Hymenogaster* by the presence of a columella. *Richoniella (Nigropogon)* has been segregated from *Hymenogaster* largely on the peculiar shape of its spores.

As in our previous work, Ridgway ('Color Standards and Color Nomenclature,' Washington, 1912) has been used as a standard for color descriptions of dried and alcoholic specimens, and such field notes as were available for fresh material, rarely based on any standard. In citing specimens examined the general plan adopted in our previous taxonomic papers, of

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[1] Published as Technical Paper No. 226, with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution from the Department of Botany in cooperation with the Henry Shaw School of Botany of Washington University.

[2] Gaumann, E. A., and C. W. Dodge. Comparative morphology of fungi, 701 pp. McGraw Hill Book Co. New York, 1928. (See pp. 488–491.)

Issued December 12, 1934.

giving the data accompanying the specimens, has been followed. In the interest of economy of space, the following designations of important collections of hypogaeous fungi have been used. Where duplicates occur in our private herbaria we have refrained from citing them unless it became necessary on account of mixtures of species under the same collector's number (e. g., a number sent us by H. E. Parks was found to differ from that same number in the herbarium at the University of California).

| | |
|---|---|
| Berlin | Miscellaneous collections in the K. Botanisches Museum zu Berlin-Dahlem. |
| Brit. Mus. | Herbaria of Broome and Ravenel, and some other collections at the British Museum of Natural History, South Kensington, London, England. |
| Dodge | Private herbarium of C. W. Dodge contains many specimens sent in for determination. |
| Farlow | Herbaria of Bucholtz, Hoehnel, Patouillard, and Thaxter, and also many sets of exsiccati and miscellaneous collections at Harvard University. |
| Hesse | Hesse Herb. at Botanische Institut, University of Marburg. |
| Kew | Berkeley Herb., especially rich in Broome, Vittadini, and E. Fries specimens, Cooke Herb. and a few other collections from Rodway and others, at the Herbarium of the Royal Botanic Gardens, Kew, Surrey, England. |
| Lloyd Mus. | Lloyd collections now in the custody of the Smithsonian Institution of Washington, D. C., formerly in the Lloyd Museum of Cincinnati. These specimens are cited under their numbers at the time of our visits, 1917 and 1923. Since then all the specimens have been given accession numbers which are much more convenient and less ambiguous, but we have not had an opportunity to examine them in their new location. |

| | |
|---|---|
| Oregon State | Herbarium of the Oregon State Agricultural College, at Corvallis, rich in miscellaneous collections from Oregon. |
| Paris | Tulasne Herb. and some miscellaneous collections in the Laboratoire de Cryptogamie, Muséum d'Histoire Naturelle, in Paris. |
| Soehner | Private herbarium of Ert Soehner, München, duplicates of many numbers in Berlin and in Dodge Herb. |
| Stanford | Harkness collections in the Dudley Herbarium of the Leland Stanford Jr. Univ., at Palo Alto, California. Since all the alcoholic material from the herbarium of H. W. Harkness at the California Academy of Sciences in San Francisco was destroyed in the fire of 1906, our knowledge of Harkness' species must be based upon these cotypes. There are also valuable collections by J. McMurphy and others here. |
| Univ. Cal. | Herbarium of the University of California, especially rich in collections of N. L. Gardner, and more recently of H. E. Parks. |
| Univ. N. Car. | Herbarium of the University of North Carolina, rich in collections of W. C. Coker and J. N. Couch. |
| Upsala | Th. M. Fries and Th. C. E. Fries collections and series of specimens sent to E. Fries, especially from Quélet, Czernaiev, Vittadini, and G. Bresadola, now in the herbarium of the Botaniska Trädgård at Upsala University. |
| Zeller | Private herbarium of S. M. Zeller, containing Pacific Coast material and many collections sent in for determination. |

We gratefully acknowledge those who have made this work possible by putting at our disposal either personal collections or the facilities of libraries and herbaria mentioned above; also Dr. J. B. Cleland, for Australian material, Dr. G. H. Cunningham, for New Zealand collections, the Istituto Botanico de Firenze, for Bornean material, the late C. H. Kauffman, for Michigan and Washington material, the late C. G. Lloyd, for many duplicates from his herbarium and for material which he had assembled on his last trip to Europe and of which his failing eyesight prevented further study, Dr. R. Maire, for Algerian material, Dr. O. Mattirolo, for Italian material, and L. Rodway for Tasmanian collections.

For financial assistance, we are grateful to the American Association for the Advancement of Science (grant in 1923 to junior author), to the Science Research Fund of Washington University (grant from Rockefeller Foundation in 1933), and to the John Simon Guggenheim Memorial Foundation which appointed the senior author a Fellow to Europe in the autumn of 1930.

### HYMENOGASTER

*Hymenogaster* Vittadini, Monogr. Tuberac. 20–25. 1831; Endlicher, Gen. Pl. 30. 1836; Corda, Anleit. z. Stud. Myc. lxxxii, 108. 1842; Icones Fung. **5**: 26. 1842; Tulasne, Ann. Sci. Nat. Bot. II. **19**: 373–375. 1843; Giorn. Bot. Ital. **1**$^{2}$: 55. 1844; Fung. Hypog. 63–74. 1851; Rabenhorst, Deutschl. Krypt.-Fl. **1**: 250–251. 1844; Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **13**: 346–350. 1844; **18**: 73–76. 1846; Fries, Summa Veg. Scand. 436. 1849; Berkeley, Outlines Brit. Fungol. 295–297. 1860; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 874–877. 1883; DeToni in Sacc. Syll. Fung. **7**:168–175. 1888; Hesse, Hypog. Deutschl. **1**:110–133. 1891; Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**:245–251. 1899; E. Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. **1**$^{**}$: 308-310. 1899; Bucholtz, Материалы къ морфологіи и систематикѣ подземныхъ грибовъ . . . Издвн. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. **1**: 154–160. 1902 [often cited as Beitr. Morph. Syst. Hypog.]; Bull. Soc. Imp. Nat. Moscou **21**: 470–484. 1908; Soehner, Hedwigia **64**: 192–202. 1923.

*Pyrisperma* Rafinesque, Med. Repository II. Hex. **5**: 355. 1808 *(nomen nudum)*; Desvaux, Jour. de Bot. **2**: 177. 1809; Lloyd, Myc. Notes 13: 130. 1903.—*Pyrispora* Endlicher, Gen. Pl. 30. 1836 *(nomen nudum)*.

*Hymenangium* Klotzsch in Dietrich, Fl. Reg. Boruss. [Fl. Königr. Preuss.] 7: no.466. 1839—*not Hymenangium* Klotzsch, *Ibid.* 6: no. 382. 1838; Corda, Anleit. z. Stud. Myc. lxxxiii, 114. 1842; Icones Fung. 5: 28. 1842 (in part).

*Splanchnomyces* Corda emend. Zobel in Corda, Icones Fung. 6: 36–45. 1854 (in part).

The type species of the genus is considered to be *Hymenogaster Bulliardi* Vittadini. In the absence of international rules for determining the type species of a genus, the rules drawn up by the Committee on Nomenclature of the Botanical Society of America (Bot. Soc. Am. Publ. 73: 70–71. 1919) are taken as the best guide available. None of the rules apply; neither does Article 7 a, c, and d of the recommendations. The last clause of Article 7e would point to *Hymenogaster Bulliardi* Vittadini, since that is unquestionably the oldest concept of the group historically. Article 7f would also point to *H. Bulliardi,* since Corda (Anleit. z. Stud. Myc. 108. 1842) so designated this species. However, Article 7b and 7g both suggest *H. citrinus* Vittadini, since the author mentions its occurrence as "frequentissimus," while that of other species is but "frequens" or "rarus." Were the genus *Hymenogaster* to be subdivided it appears extremely improbable that *H. citrinus* and *H. Bulliardi* would be found in different groups, since they seem to be much more nearly related than many of the other species; hence the first two clauses of 7e do not affect the decision. And finally, *H. citrinus* is the first in the genus, if these two species are considered to be otherwise of equal eligibility.

Fructifications subspherical, reniform, pyriform, or irregular; fibrils rarely present, then merely basal leading to rhizomorphs; peridium usually simple, prosenchymatous, pseudoparenchymatous, or stupose, usually confluent with the septa of the gleba, indehiscent; gleba colored as the spores, lacunose, chambers empty, then partially filled with spores, irregular or more or less radiating from a sterile base; septa usually of the same structure as the peridium, relatively thin, often very fragile when dry; sterile base usually present, especially more prominent in young specimens, pulvinate to conical; basidia 1–4-spored; spores colored, usually some shade of brown, ochre, or almost black at maturity, ovoid, obovoid, ellipsoid, citriform, fusiform, or lanceolate, with or without apiculus, with or without persistent pedicel, surface smooth to verrucose, rugose, alveolate, or reticulate, with or without a more or less wrinkled utricle.

The peridium and tramal tissues of the gleba are little differentiated in the young stages. In some species they never undergo further differentiation, while in others the outer hyphae become larger and form a coarse stupose outer layer which gradually merges into the gleba. The cavities develop schizogenetically in the upper portion of the fructification, leaving a large more or less hemispherical to conical sterile base which persists for a long time, occasionally to maturity. As the cavities expand above, the lower ones next the sterile base are stretched longitudinally so that they appear to radiate from the sterile base. The septa are very broad at first and gradually shrink until they are very thin, often fragile, occasionally scissile. The subhymenium is often pseudoparenchymatous, the basidia are usually cylindrical and so evanescent that they are rarely observable in mature fructifications. On drying, the tissues throughout the fructification collapse, and thus measurements based on dry material are many times less than those based on fresh specimens or on those preserved in alcohol. When a fructification has been preserved in alcohol for a time and then allowed to dry out, the tissues are *still more* collapsed and it is almost impossible to distinguish structures. Since most of the material available in this work has been dried, unless otherwise noted the measurements and the structures observable in the dry material have been given in our descriptions and keys. One who intends to prepare herbarium material of this genus should make careful field notes of color, odor, and size, and preserve most of the material in alcohol or alcohol to which 10 per cent glycerol has been added, drying one fructification in order to compare with dry material to be found in other herbaria. Exceptionally fine material received from Prof. James McMurphy, Stanford University, was preserved in a mixture of 900 cc. of 50 per cent alcohol, 50 cc. of 40 per cent formalin, 25 cc. of glycerine, and 25 cc. of glacial acetic acid. It is sometimes advantageous to kill immediately in formal-acetic-alcohol, which may be used as a preservative as well as a mordant. Such material may be imbedded for histological purposes or studied by free-hand or freezing-microtome sectioning.

The geographical distribution of *Hymenogaster* is similar to that of the larger genera so far studied except *Melanogaster*. The European flora has been the most thoroughly studied by a long line of investigators and collectors. At present fifty-nine species are reported although it seems likely that some may be synonyms, as some of the types of Hesse's species and the type of *H. rufus* have been unavailable. The Pacific flora, from Japan, Oregon, California, Chile, and Australasia, where collection and study are more sporadic, is represented by twenty-nine species. In Oregon and California, besides the species common to Australasia and a few not known from other regions, there are several European species represented, most of these also found in eastern North America. Only one of the European species has been found in South America and none in Australasia. The Australasian species are small-spored, except *H. fusisporus*, where the epispore is often finely verrucose, not coarsely so as in the *H. tener* and the *H. muticus* group of Europe. *Hymenogaster zeylanicus*, so far as known endemic in the mountains of Ceylon, seems more closely related to the Australasian group, although superficially it also resembles *H. cerebellum* of northern Italy.

In the descriptions of the spores, the measurements have included the utricle and other spore markings unless otherwise stated. The utricle is a more or less loosely applied membranous envelope, which may be smooth or variously wrinkled. This where present is in addition to the epispore which may be smooth, variously verrucose, rugose, alveolate, or reticulate. The thickness of the epispore may not be apparent in optical section. There is considerable variation in the shape of the citriform spores. In our descriptions we have used the terms ellipsoid-citriform, ovoid-citriform, or obovoid-citriform when the short diameter of the spore is at, below, or above the middle of the long diameter. In many species the shape appears variable in a given fructification, due to the presence of immature spores. In the following descriptions, mature spores have been assumed to be those with the darkest color although they may not be the largest. The very young spore still attached to the basidium is usually ellipsoid or obovoid and quite regular in outline. In many species the next stage is characterized by a well-developed apiculus (which may be relatively enormous in *H. olivaceus*) and a tendency toward ovoid shape. As the spore matures the apiculus becomes shorter (and may disappear or break off as in *H. olivaceus*) and the spore becomes a darker brown, and may shrink somewhat in volume and, becoming more rounded, produce the characteristic markings of the epispore and utricle.

### KEY TO SPECIES OF HYMENOGASTER

1. Peridium drying more than 300 μ thick.............................. 2
1. Peridium drying between 200 and 300 μ thick.......................... 3
1. Peridium drying between 130 and 200 μ thick.......................... 5
1. Peridium drying between 70 and 130 μ thick........................... 14
1. Peridium drying less than 75 μ thick................................. 28
    2. Peridium 320–1000 μ thick, white, changing to pink to red or purple when touched; spores broadly ellipsoid, rounded above, truncate below, verrucose, 7–10 × 5–6 μ.................................*H. ruber* (p. 636)
    2. Peridium drying 400–640 μ thick, greenish-yellow above, pale yellow to almost white below, drying chamois to brownish; spores smooth to very finely verrucose, 4–5-angled in optical-section, 10–14 × 5–7.5 μ.................................................*H. pachydermis* (p. 637)
3. Spores smooth with a thick epispore, broadly citriform with apiculus, 22–26 × 12–15 μ [cf. *H. uliginosus* (p. 639)]............*H. Bulliardi* (p. 638)
3. Spores at least slightly roughened, not apiculate...................... 4
    4. Spores more than 18 μ long, oblong-ellipsoid or fusiform, slightly roughened, slightly pedicellate, 19–23 × 9.5–12 μ..*H. lycoperdineus* (p. 639)
    4. Spores more than 8 μ broad, broadly ellipsoid or ovoid, rounded at both ends, evenly and finely verrucose, with utricle before maturity, 11.4–17 (–18.5) × 8–11 μ..............................*H. albus* (p. 640)
    4. Spores less than 8 μ broad, obtusely obovoid to ellipsoid, finely warted or asperulate, 10–13 × 6–8 μ............................*Arcangeliella nana*
5. Peridium duplex or at least of two more or less distinct layers............ 6
5. Peridium simplex, homogeneous or with no more differentiation than a darker rind of superficial hyphae distinct from the general context of the peridium .................................................... 7

6. Surface viscid, outer gelified, clear layer 30–40 μ thick (dry), inner layer stupose, 90–130 μ thick; spores broadly oblong-ellipsoid, obtuse at both ends, 13–15.5 × 9–10.5 μ............................*H. viscidus* (p. 642)

6. Surface not viscid, outer layer cottony, inner layer prosenchymatous; spores mostly obovoid, with or without apiculus, verrucose to roughly beaded, 14.8–18.5 × 8–11 μ............................*H. tener* (p. 642)

6. Surface not viscid, outer layer fibrous, inner layer parenchymatous; spores ellipsoid, attenuate at ends, mucro free when young, becoming involved in exospore, 20–30 × 12–18 μ................*H. Bucholtzi* (p. 644)

7. Surface and gleba changing to bluish when bruised, pyriform with a prominent sterile base; spores rounded above, rugose as mere striations, 12–23 × 9–11 μ....................................*H. pyriformis* (p. 644)

7. Surface and gleba not changing to bluish where bruised................. 8

8. Spores less than 15 μ long........................................... 9

8. Spores more than 15 μ long........................................... 10

9. Peridium prosenchymatous; spores more than 8 μ broad, verrucose, covered by a closely applied utricle, 12–15 × 8–11 μ.........*H. cerebellum* (p. 645)

9. Peridium stupose; spores less than 8.5 μ broad, with flaking utricle, verrucose, 11–12 × 7–8 μ..................................*H. fragilis* (p. 646)

10. Spores apiculate, utricle very prominently roughened or torn........ 11

10. Spores not apiculate, utricle not prominently roughened or torn, except in *H. Gardneri*................................................ 12

11. Spores more than 12 μ broad; fructifications lemon-yellow when fresh, becoming fragile, carbonaceous at maturity [cf. *H. pruinatus* (p. 648)]..... ....................................................*H. citrinus* (p. 646)

11. Spores less than 12 μ broad; fructifications white to grayish when fresh, drying buff ..........................................*H. Gilkeyae* (p. 649)

12. Spores with a thick prominent epispore and very much roughened and torn, dark utricle, 18.5–26 × 11.5–14 μ...............*H. Gardneri* (p. 649)

12. Spores without a prominent epispore, and utricle thin, slightly wrinkled. 13

13. White, drying light yellow, surface flocculent to innate-fibrillose; peridium loosely stupose; spores ellipsoid or ovoid, broadly rounded at both ends, evenly and finely beaded at maturity, utricle wrinkled in immature spores, 11.4–17 (–18.5) × 8–11 μ................................*H. albus* (p. 640)

13. White, drying dark brown, surface smooth, hard, then cracked; peridium of homogeneous prosenchyma; spores obovoid, ellipsoid, broadly rounded above, almost smooth, then quite coarsely verrucose, 18–23 × 10–15 μ [cf. *H. pilosiusculis* (p. 651)]............................*H. muticus* (p. 650)

13. White, drying cinnamon-buff to snuff-brown, surface whitish-villous; peridium densely stupose; spores ellipsoid with undulating surface and wrinkled clear utricle, 20–25 × 11–13 μ, pedicel 3–4 μ in diameter....*H. griseus* (p. 651)

14. Fructifications white, becoming bluish or bluish-green when bruised; spores with utricle having about 8 longitudinal folds................ ...............................................*H. caerulescens* (p. 652)

14. Fructifications white, becoming yellowish when bruised.*H. cinereus* (p. 653)

14. Fructifications changing to brownish or reddish-brown when bruised... 15

14. Fructifications unchanged or merely changing to dirty brownish when bruised ................................................... 16

15. Spores broadly lanceolate or fusiform, with a longitudinally wrinkled utricle, 26–40 × 7.4–10.5 μ............................*H. Boozeri* (p. 653)

15. Spores ovoid- to ellipsoid-citriform, with an apiculus, rough, coarsely verrucose, 15–18.5 × 9.5–11.5 μ............................*H. niveus* (p. 654)

15. Spores broadly fusiform or obovoid, finely verrucose or wrinkled, 15–22 × 7–10 μ......................................*H. spictensis* (p. 655)

16. Surface distinctly viscid when moist; peridium duplex; spores minutely roughened, oblong-ellipsoid, both ends obtuse, 13–15.5 × 9–10.5 μ...........................................................*H. viscidus* (p. 642)

16. Surface not viscid, peridium simple.............................. 17

17. Spores covered by an open reticulate network of very distinct ridges, apiculate, citriform, 14.5–16 (–18.5) × 9.6–11 (–11.5) μ.....*H. reticulatus* (p. 656)

17. Spores seldom covered by a distinct network, if so partly obscured by verrucae or other markings................................................ 18

18. Spores subspherical, minutely alveolate over the entire surface, 11.5–15 × 10–11.5 μ, very dark.......................... *H. atratus* (p. 656)

18. Spores of other shapes, and if alveolate not uniformly so over the entire surface................................................ 19

19. Spores less than 17 μ long............................................ 20

19. Spores more than 17 μ long.......................................... 22

20. Spores more than 8.5 μ broad, apiculate, broadly ellipsoid to citriform, roughly verrucose, 12–15 × 9–11 μ.................*H. mutabilis* (p. 657)

20. Spores more than 8.5 μ broad, rounded above, sculptured by small short ridges, yellow, 12–13 (–14.5) × 9.5–11 (–14) μ....*H. McMurphyi* (p. 658)

20. Spores less than 8.5 μ broad.................................... 21

21. Fructifications yellowish-white; spores ellipsoid, exospore wrinkled, 12–16 × 5–7 μ.....................................*H. disciformis* (p. 658)

21. Fructifications whitish, becoming dirty white or buff on drying; spores broadly fusiform or ellipsoid, verrucose, apiculate, 11–12 × 7–8 μ..................................................................*H. fragilis* (p. 646)

21. Fructifications violet, turning brownish on drying; spores ellipsoid, finely areolate-verrucose, obtusely pointed, 8–10 (–11) × 4.4–5.6 (–7) μ..........................................................*Arcangeliella Campbellae*

21. Fructifications white, becoming subfuscous; spores fusiform, exospore slightly roughened....................................*H. minusculus* (p. 659)

22. Spores with a very loosely applied utricle at maturity.............. 23

22. Spores with a closely applied, only somewhat wrinkled utricle at maturity .......................................................... 27

23. Fructifications lemon- or golden-yellow when fresh, drying brown; gleba drying almost black at maturity; spores large, 20–33 × 13–17 μ...........................................................*H. citrinus* (p. 646)

23. Fructifications white or grayish when fresh.......................... 24

24. Spores averaging less than 11 μ broad, at maturity very dark and oblong including loose utricle, young spores apiculate, obovoid or long-cylindrical, 17–23 × 10–12.5 μ....................*H. verrucosus* (p. 659)

24. Spores averaging more than 11 μ broad.......................... 25

25. Gleba lilac-colored when fresh, becoming fuliginous; spores 18–24 × 12–14 μ (uncommon)....................................*H. lilacinus* (p. 660)

25. Gleba some shade of gray or brown when fresh; epispore thick, distinct... 26

26. Spores not apiculate, spherical when young, later ellipsoid, 20–30 × 15–20 μ........................................*H. eurysporus* (p. 661)

26. Young spores obtuse, rounded at distal end, not apiculate, with longitudinal folds in utricle, mature spores ellipsoid, tapering to both ends, 18.5–26 × 11.5–14 μ................................*H. Gardneri* (p. 649)

26. Young spores with a long, cylindrical or capitate apiculus, lanceolate, 29–42 × 11–14 μ, more or less smooth utricle, guttulate; mature spores oblong-ellipsoid, rounded at both ends, guttulate, 19–29 × 12–14 μ..........................................................*H. olivaceus* (p. 661)

27. Spores fusiform, tapering to both ends, pointed above, without apiculus, utricle longitudinally or diagonally wrinkled, 22–33 × 9–14.8 μ [cf. *H. gilvus* (p. 667)].....................................*H. vulgaris* (p. 664)

27. Spores ovoid-ellipsoid, obtuse above, slightly roughened utricle, short-pedicellate, 18.5–26 × 10–18.5 μ [cf. *H. reniformis* (p. 179)]..........................................................*H. populetorum* (p. 667)

27. Spores mostly ellipsoid, slightly broad-apiculate or sometimes broad-rounded above, verrucose, with slightly retrorse verrucae and covered by a smooth utricle, 20–26 × 12–15 μ.....................*H. occidentalis* (p. 668)

27. Spores mostly obovoid, undulating, verrucose, 22 × 14 μ..*H. Thwaitesii* (p. 669)

28. Spores subspherical, alveolate, very dark, 11.5–15 × 10–11.5 μ.........................................................*H. atratus* (p. 656)

28. Spores ellipsoid, fusiform, ovoid, etc., with variously marked epispores 29

29. Spores apiculate........................................... 30

29. Spores not apiculate....................................... 36

30. Spores with a utricle...................................... 31

30. Spores without a utricle................................... 34

31. Spores averaging less than 11 μ broad, ellipsoid-citriform, 14.5–17 × 9.6–11.1 μ [cf. *H. javanicus* (p. 670)]..................*H. albellus* (p. 669)

31. Spores averaging more than 11 μ broad............................ 32

32. Spores long-pedicellate, fusoid-citriform, with a thin, flaking utricle, 24–36 × 10–16 μ.................................*H. sulcatus* (p. 671)

32. Spores not long-pedicellate.................................... 33

33. Spores broadly obovoid, with a broad, stout, claw-like pedicel, very rough, 16–22 × 10–15 μ....................................*H. Hessei* (p. 672)

33. Young spores apiculate, lanceolate, 29–42 × 11–14 μ, mature spores oblong, rounded at both ends, roughened with a loose utricle, guttulate, 19–29 × 12–14 μ..........................................*H. olivaceus* (p. 661)

33. Young spores obtuse, ellipsoid, tapering to both ends, mature spores ellipsoid, retrorsely verrucose, covered by a smooth utricle, 20–26 × 12–15 μ.........................................................*H. occidentalis* (p. 668)

34. Spores less than 8.5 μ broad.......................*H. fragilis* (p. 646)

34. Spores 8–9 μ broad, fusiform, 20–22 μ long.........*H. fusisporus* (p. 673)

34. Spores more than 8.5 μ broad.................................... 35

35. Spores citriform, dark, wrinkled, 27–29 × 11–13 μ......*H. tomentellus* (p. 673)

35. Spores obovoid or broadly ellipsoid-citriform, dark, verrucose, 18.5–26 × 12.2–17 μ.........................................*H. Parksii* (p. 674)

35. Spores broadly ovoid-citriform, coarsely verrucose, 11–18 × 8.5–11 μ..........................................................*H. arenarius* (p. 674)

35. Spores ovoid-citriform to ellipsoid-citriform, exospore thick, coarsely roughened, 15–18.5 × 9.5–11.5 μ........................*H. niveus* (p. 654)

    36. Spores utriculate ........................................ 37

    36. Spores not utriculate........................................ 41

37. Spores less than 11 μ broad........................................ 38

37. Spores more than 11 μ broad........................................ 39

    38. Spores ellipsoidal, 12–16 × 5–7 μ................*H. disciformis* (p. 658)

    38. Spores ovoid-citriform, 13–15 × 8–10 μ............*H. zeylanicus* (p. 676)

    38. Spores ellipsoid-citriform, 14.5–17 × 9.6–11 μ.........*H. albellus* (p. 669)

    38. Spores ellipsoid, 16–19 × 6–10 μ......................*H. cereus* (p. 677)

39. Gleba lilac, becoming fuliginous; young spores obtuse-rounded above, 18–24 × 12–14 μ..................................*H. lilacinus* (p. 660)

39. Gleba some shade of gray or brown, drying snuff-brown................ 40

    40. Spores definitely verrucose, covered by a smooth utricle, 20–26 × 12–15 μ, ellipsoid, apiculus if present short, broad..*H. occidentalis* (p. 668)

    40. Spores smooth, covered by a more or less roughly wrinkled, loose utricle, young spores guttulate, fusiform, with long or capitate apiculus, 29–42 × 11–14 μ, mature spores guttulate, oblong with both ends rounded, utricle prominently loosely wrinkled, 19–29 × 12–14 μ........ ..........................................*H. olivaceus* (p. 661)

41. Spores more than 8 μ broad, smooth, clear yellow, mostly ovoid, 18–22 × 9–11 μ..........................................*H. luteus* (p. 677)

41. Spores 9.5–11 μ broad, roughened by small short ridges, ovoid............ .........................................*H. McMurphyi* (p. 658)

41. Spores less than 8 μ broad, mostly obovoid or subspherical.............. 42

    42. Spores broadly obovoid-ellipsoid to subspherical, slightly pedicellate, smooth, but slightly asperulate at the distal end, 8–9 × 5.5–6 μ........ ..........................................*H. levisporus* (p. 678)

    42. Spores broadly obovoid-ellipsoid, attenuated below, minutely verrucose with rather distinct warts at the distal end, 8–11 × 5.5–7.5 μ.......... .............................................*H. Remyi* (p. 679)

    42. Spores ovoid to oblong, 10–12 × 6 μ.................*H. Maideni* (p. 679)

1. **HYMENOGASTER RUBER** Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 246. 1899; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 254. 1902.

*Hymenogaster versicolor* Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 245. 1899; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 254. 1902.

Type: cotypes in Dudley Herb. at Stanford Univ.

Fructifications 1 × 2 × 4 cm., subspherical to oblong, white, becoming pale red and turning purple when touched, dark reddish in alcohol, surface flocculose; peridium varying greatly in thickness, about 320–1000 μ thick, the outer portion (about half) composed of coarse, stupose, thick-walled, intertwined hyphae, and the inner portion of fine parallel hyphae, approaching prosenchyma in places; gleba isabella color, with flecks of the white septa, cavities small, filled with spores; septa 15–25 μ between hymenia, composed of slender, much-gelified, hyaline hyphae; basidia truncate-clavate, 20 × 6–7 μ, sterigmata 10–12 μ long, stout; spores olivaceous-brown, ellipsoidal to obovoid, 5–6 × 7–10 μ, verrucose with a broad attachment, exospore distinct.

Under *Quercus* and *Pseudotsuga*. Oregon, California and Chile. March to July.

The spores are olivaceous and have the general shape of the short ones in some species of *Hysterangium*. The broad scar of the sterigma, leaving the spore almost truncate below, and the general appearance of the gleba are also suggestive of *Hysterangium*. The species is included here because of the verrucose spores and the lack of a columella.

OREGON: Linn County, Roaring River Fish Hatchery, *S. M. Zeller 8208* (Zeller).

CALIFORNIA: Marin County, Mill Valley, *H. W. Harkness 248*, cotype of *H. ruber*, and *174*, cotype of *H. versicolor* (Stanford); Mt. Tamalpais, *H. E. Parks, 3100* (Univ. Cal.); Muir Woods, *C. W. Dodge 1577* (Dodge and Zeller).

CHILE: Magellanes, Punta Arenas, *R. Thaxter*, Hypog. 9 (Farlow).

### 2. HYMENOGASTER **pachydermis** Zeller & Dodge, sp. nov.

Fructificationes oblate spheroideae, 2–4 cm. diametro, 2.5–3 cm. altitudine, viridi-luteae, "chamois" vel buckthorn-brown" siccatae superne, subluteae vel albidae "cartridge-buff" vel "chamois" siccatae inferne, laeves vel innato-fibrillosae; basis sterilis inconspicua; peridium crassum, 2 mm. recens, 400–640 μ siccatum, dilute luteum, prosenchymaticum, superficie hyphis magnis laxis; gleba dilute brunnea, "walnut-brown" vel "Vandyke brown" siccata, locellis parvis; septa 10–20 μ crassitudine, hyphis periclinalibus gelificatis, scissilia magnis cum lacunis in angulis; basidia anguste clavata 10–14 × 4–5 μ, tetraspora; sporae ellipsoideae, ovoideae vel obovoideae, laeves vel minute verruculosae, 4–5 angulatae in sectione optica, 10–14 × 5–7.5 μ.

Type: in Cunningham, Dodge, and Zeller Herbaria.

Fructifications oblate spheroidal to chestnut-shaped, 2–4 cm. broad, 2.5–3 cm. high, firm, greenish-yellowish above to pale yellowish or almost white below when fresh, drying cartridge-buff to chamois below and chamois to buckthorn-brown above, surface smooth to soft dull innate-fibrillose; sterile base not conspicuous; peridium very thick, 2 mm. when fresh, drying

400–640 μ, dilute yellowish, homogeneous, prosenchymatous, with a surface of large loose hyphae; gleba light brown, drying walnut-brown to Vandyke brown, firm, cavities tiny at first, becoming larger with age (even splitting into very large hollows because of scissile septa); septa hyaline, of large gelified parallel hyphae, scissile with large openings at the angles, 10–20 μ thick; basidia narrowly clavate, 10–14 × 4–5 μ, 4-spored; spores ellipsoid, ovoid or obovoid, smooth to very finely verrucose, 4- to 5-angled in cross-section, 10–14 × 5–7.5 μ, light yellowish-brown *sub lente*.

Under leaves or on the ground under *Alnus, Eucalyptus,* and *Fagus.* Oregon, California, Australia, and New Zealand. November to April.

OREGON: Benton County, *S. M. Zeller 2260* (Zeller).

CALIFORNIA: Alameda County, Shepard Cañon, near Oakland, *H. E. Parks 1167a,* and *C. W. Dodge 1586a* (Univ. Cal., Dodge, and Zeller).

AUSTRALIA: Victoria, Follett County, *F. M. Reader* (Lloyd Mus., 06150).

NEW ZEALAND: North Island, Wellington, York Bay, *E. H. Atkinson* (com. G. H. Cunningham 1100); South Island, Nelson, Dun Mountain, *J. C. Neill,* type (com. G. H. Cunningham 1096, all Dodge and Zeller).

3. HYMENOGASTER BULLIARDI Vittadini, Monogr. Tuberac. 23. 1831; Tulasne, Ann. Sci. Nat. Bot. II. **19**: 374. 1843; Fung. Hypog. 71. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 876. 1883; DeToni in Sacc. Syll. Fung. **7**: 168–169. 1888.

*Tuber moschatus* Bulliard, Herb. France. II. Hist. Champ. **1**: 79. 1791; Bulliard & Ventenant, Hist. Champ. France, ed. 2. **1**: 79. 1809.

Illustrations: Bulliard, Herb. France. II. Hist. Champ. *pl. 479;* Tulasne, Ann. Sci. Nat. Bot. II. **19**: *pl. 17, f. 14–16;* Fung. Hypog. *pl. 10, f. 6;* Vittadini, Monogr. Tuberac. *pl. 3, f. 5.*

Type: specimens so determined in Broome Herb. (Brit. Mus.), E. Fries Herb. (Upsala), Bot. Mus. Berlin, and Tulasne Herb. at Paris.

Fructifications subspherical, 2.5–3.5 cm. in diameter, drying about 1.6 cm., sulcate, depressed below, surface smooth, dark, dirty brown, drying isabelline; peridium thick, drying 220–250 μ, loosely stupose, spongy, of large thin-walled prosenchyma, with peculiar hyaline, burr-like inclusions, somewhat tenacious, not separable; gleba dense, dark ferruginous, drying Argus brown, cavities very small, nearly filled with spores at maturity; septa thin and fragile, drying 20–30 μ thick, dark brown, rather more hyaline toward the middle, but not truly scissile; basidia narrowly clavate, 4-spored; spores dark ferruginous, clear citrine under microscope, broadly citriform, rounded at the base, and broadly rounded above with small apiculus, epispore thick, smooth, 22–26 × 12–15 μ, pedicellate. Odor strong like that of bugs. (fide Vittadini).

In deciduous forests of hills and mountains. Italy and France. Spring to October.

ITALY: Lombardia, Milano, *C. Vittadini* (Brit. Mus., Lloyd Mus., Upsala, Berlin, and Paris).

FRANCE: Seine, Vincennes, *Tulasne,* Oct. 29, 1843 (Paris).

4. HYMENOGASTER ULIGINOSUS Soehner, Krypt. Forsch. 1: 395. 1924.

Type: in Soehner Herb. but not seen.

Fructifications white, finally becoming fuscous, moderately regular, spherical, glabrous, up to 1 cm. in diameter, very firm; peridium 200–250 μ thick, pseudoparenchymatous, with hyphae collapsing without; gleba at first white, becoming dirty amethyst and violet, finally fuscous, cavities small; basidia 2-spored, clavate or cylindric, yellowish, 20–30 × 7–10 μ; spores almost opaque, with large oil drops, exospore thin, obovoid, with short retuse papillae, remains of broad and conspicuous sterigmata, 22–32 × 10–14 μ. Odor earthy or marshy.

In marshy soil in pine woods. Ismaning, Germany.

5. HYMENOGASTER LYCOPERDINEUS Vittadini, Monogr. Tuberac. 22. 1831; Tulasne, Fung. Hypog. 64. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. 1: 874. 1883; DeToni in Sacc. Syll. Fung. 7: 171. 1888.

*Splanchnomyces lycoperdineus* Corda, Icones Fung. 6: 42. 1854.

Illustrations: Corda, Icones Fung. 6: *pl. 7, f. 81;* Tulasne, Fung. Hypog. *pl. 10, f. 5;* Vittadini, Monogr. Tuberac. *pl. 2, f. 5.*

Type: location unknown to us, although material from Vittadini in Broome Herb., Berk. Herb., Fries Herb., Tulasne Herb., and slide from type in Lloyd Mus.

Fructifications spherical to irregular, the size of a walnut, surface silky, smooth, fuliginous-white, drying chamois; peridium 200–250 μ thick, composed of densely woven, stupose hyphae; gleba white, becoming pale ferruginous, cavities large, radiating from the base; septa hyaline, prosenchymatous, 35–42 μ thick; basidia slender-clavate, 2-spored; spores 19–23 × 9.5–12 μ, oblong-ellipsoid to fusiform, very dark, very slightly rough with a scarcely distinct appendiculus. Odor of onions or old cabbage stalks.

In clay. U. S. S. R. and Italy.

This species closely resembles *Tuber Borchii* in appearance and color.

U. S. S. R. [RUSSIA]: Moskva, road to Pleskovo, near Mikhailovskoe, *F. Bucholtz*, July 29, 1906 (Farlow).

ITALY: Lombardia, *C. Vittadini* (two slides in Lloyd Mus., one marked "type, Vitt.," the other "ex Vitt."); Milano, *C. Vittadini* (Kew and Upsala).

6. HYMENOGASTER ALBUS (Klotzsch) Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **13**: 349. 1844; Fries, Summa Veg. Scand. 436. 1849.

*Rhizopogon albus* Berkeley in Smith, Brit. Fl. **5**$^2$: 229. 1836, ? excl. syn.—*not* Fries, 1821.

*Hymenangium album* Klotzsch in Dietrich, Fl. Reg. Boruss. [Fl. Königr. Preuss.] **7**: no. 466. 1839; Corda, Anleit. z. Stud. Myc. lxxxiii. 1842.

*Splanchnomyces albus* Corda, Icones Fung. **6**: 40. 1854.

*Hymenogaster Klotzschii* Tulasne, Fung. Hypog. 64. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 875. 1883; DeToni in Sacc. Syll. Fung. **7**:170. 1888; Massee, Ann. Bot. **4**: 42. 1889 [often cited as Monogr. Brit. Gast. 42. 1889]; Hesse, Hypog. Deutschl. **1**:123–124. 1891; Th. M. Fries, Svensk Bot. Tidskr. **3**:275–276. 1909; Th. C. E. Fries, Ark. f. Bot. **17**$^9$: 13. 1921.

Illustrations: Corda, Anleit. z. Stud. Myc. *pl. D, f. 47*$^{7-10}$; Icones Fung. **6**: *pl. 8, f. 82;* Cordier, Champ. *pl. 59, f. 2;* Hesse, Hypog. Deutschl. **1**: *pl. 2, f. 10–13; pl. 7, f. 48;* H. Hoffmann, Bot. Zeit. **14**: *pl. 5, f. 30;* Jahrb. f. wiss. Bot. **2**: *pl. 31, f. 31;* Klotzsch in Dietrich, Fl. Reg. Boruss. [Fl. Konigr. Preuss.] **7**: no. 466; Massee, Ann. Bot. **4**: *pl. 1, f. 24* [Monogr. Brit. Gast. *pl. 1, f. 24*]; Nees, Syst. d. Pilze, *pl. 27, f. 1–4;* Tulasne, Fung. Hypog. *pl. 10, f. 12.*

Type: The type of *Hymenangium album,* which is also theoretically the type of *Hymenogaster Klotzschii* Tulasne, was collected by Carl Bouché and Klotzsch in the botanical garden at Grünewald, near Berlin, but apparently no material has survived as it was not found in Berlin, Kew, nor Paris and was not seen by Tulasne. The type of *Rhizopogon albus* Berkeley (*non* Fries) and *Hymenogaster albus* Berkeley & Broome was based on material collected by J. D. Hooker, October, 1830, in the Botanic Garden at Glasgow, found in the Berkeley Herbarium at Kew, and better material in Berlin bearing the name "*Hymenangium album* Klotzsch" in Klotzsch's handwriting. One slice of this same material communicated by Berkeley is in Tulasne's herbarium at Paris and is the actual specimen upon which he based his description of *H. Klotzschii.* Therefore the Glasgow material should be considered the type of the species. In the description of *Rhizopogon albus* Berkeley (*non* Fries), Berkeley also cites a collection from Acton Burnell by Stackhouse which was not found at the British Museum nor at Kew.

Fructifications spherical, drying 0.5–2 cm. in diameter, white, drying maize-yellow with the darker portions buff-yellow; peridium flocculently stupose, 150–250 μ thick, the outer hyphae large, varicose, up to 13–14 μ in diameter, golden-yellow in mass, the inner more closely stupose and lighter yellow; gleba drying cinnamon-buff to tawny olive, cavities large, often 400 × 100 × 130 μ; septa 25–40 μ thick; spores ovoid to broadly ellipsoid or sometimes citriform, 11.4–17 (–18.5) × 8–11 μ, averaging 14 × 9.5–10 μ, rather finely and evenly beaded as seen in optical section, or rather coarsely verrucose toward the distal end, mostly without appendiculus.

On pots of cultivated plants, often *Eucalyptus,* in greenhouses, at various times of year. The native locality of this species is unknown but we suspect that it will be found in the Australian or western American flora as it seems more nearly related to the species of these regions than to any European species.

EXSICCATI: Klotzsch, Herb. Viv. Myc. ed. 1, [Rabenhorst] 242, 1967.

SWEDEN: Upsala, Bot. Trädgård, *Gunnar Fries,* 1893, *Th. C. E. Fries,* 1905, *T. Lyenberg,* 25 XI, 1905 (all Upsala).

ITALY: *Mattirolo 10* (Lloyd Mus.).

GERMANY: Berlin, *P. Hennings,* Dec. 9, 1894 (Upsala), 1895, Apr., 1904 (Lloyd Mus. 04146); Giessen, *A. Braun,* 1853 (Berlin), *H. Hoffmann,* 1853, in Klotzsch, Herb. Viv. Myc. ed. 1, [Rabenhorst] 1967 (Farlow); Breslau, *L. Becker,* Feb., 1873, ex Herb. Thümen (N. Y. Bot. Gard. and Lloyd Mus. 0212).

GREAT BRITAIN: Scotland, Glasgow, *J. D. Hooker,* type (Kew, Berlin, and Paris).

MASSACHUSETTS: Cambridge, *R. Thaxter,* 1891, 1892 (Farlow).

CALIFORNIA: Alameda County, Berkeley, Botanic Garden, *G. Hahn* (com. N. L. Gardner 481, Univ. Cal. and Zeller).

7. **HYMENOGASTER VISCIDUS** Massee & Rodway, Kew Bull. Misc. Inf. **1898**: 127. 1898.

Illustrations: Rodway, Papers & Proc. Roy. Soc. Tasmania **1911**: *pl. 3, f. 8.*

Type: in Kew Herb.

Fructifications irregular, oblong, chestnut to chocolate, viscid, 3 × 1.5 cm.; peridium thick, tough, easily separable from the gleba, with outer gelified layer of periclinal hyphae 30–40 μ thick, inner layer 90–130 μ thick, of dark reddish-brown hyphae; gleba pale at first, dark brown in age, cavities radiating from the base, small, irregular; septa thick, brown, not scissile; basidia 3–4-spored; spores broadly oblong-ellipsoid, obtuse at both ends, 13–15.5 × 9–10.5 μ, minutely roughened, yellowish-brown to dirty brown in mass.

Oregon and Tasmania. (Under *Corylus,* Oregon. June.)

OREGON: Benton County, Noon, *J. L. Mielke* (Zeller 7631).

TASMANIA: Hobart, *L. Rodway 270,* type (Kew), *1115* (Lloyd), *1272a* (Dodge and Zeller).

8. **HYMENOGASTER TENER** Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **13**: 349. 1844; Ann. & Mag. Nat. Hist. I. **18**: 75. 1846; Tulasne, Fung. Hypog. 72. 1851; Berkeley, Outlines Brit. Fungol. 296. 1860; DeToni in Sacc. Syll. Fung. **7**: 174. 1888;

Massee, Ann. Bot. **4**: 46–47. 1889 [often cited as Monogr. Brit. Gast. 47–48. 1889]; Hesse, Hypog. Deutschl. **1**: 122. 1891.

*Hymenogaster argenteus* Tulasne, Giorn. Bot. Ital. **1**$^2$: 55. 1844.

*Hymenogaster lilacinus* Berkeley, Brit. Fung. 305, *pro parte.—not H. lilacinus* Tulasne, Ann. Sci. Nat. Bot. II. **19**: 374. 1843.

*Splanchnomyces tener* Corda, Icones Fung. **6**: 44. 1854.

Illustrations: Tulasne, Fung. Hypog. *pl. 1, f. 4; pl. 10, f. 1;* Massee, Ann. Bot. **4**: *pl. 1, f. 1; pl. 4, f. 54;* Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 47;* Corda, Icones Fung. **6**: *pl. 13, f. 108.*

Type: in Berkeley Herb. at Kew, distributed as *H. lilacinus* in Berkeley, British Fungi, 305. This material is mostly *H. citrinus,* but occasionally a fructification of *H. tener* may be found. The type of *H. argenteus* from France: Seine, Bois de Boulogne, *Tulasne,* is in Broome Herb. and Tulasne Herb.

Fructifications small, about 1 cm. in diameter, white, becoming dirty white, silky, smooth, sterile base hemispheric to conical in young plants, disappearing at maturity; peridium duplex, the outer layer stupose with soil inclusions, up to 480 µ thick, drying 100–200 µ, the inner layer of prosenchyma drying 37–50 µ; gleba white at first, becoming a delicate pink and finally umber-gray; septa hyaline, 30–40 µ thick, prosenchymatous, subhymenium pseudoparenchymatous; basidia 1–4-spored, broadly clavate, about 19 × 11 µ; spores ellipsoid to ovoid-citriform, apiculate when young, obovoid with rounded ends at maturity, surface verrucose to roughly verrucose, covered by a utricle, 14.8–18.5 × 8–11 µ.

Hypogeous in hard soil under *Quercus.* Europe and United States. September to December.

U. S. S. R. [RUSSIA]: Moskva, Mikhailovskoe, *N. Mossolov,* July 25, 1906 (sub *H. arenarius*); road to Sekirino, *F. Bucholtz,* July 25, 1906; road to Pleskovo, *F. Bucholtz,* Aug. 7, 1906; Voronovo, *F. Bucholtz,* Aug. 20, 1907 (all Farlow).

SWEDEN: Uppland, Upsala Bot. Trädgård, *Th. M. Fries,* Feb., 1879 (sub *Hydnangium carneum,* Upsala).

DENMARK: Nyköbing, Falster Vesterskov, *F. H. Möller* (Landbohojskolen, Köbenhavn).

GERMANY OR AUSTRIA: (no locality, specimen marked "Tannenwald 6-7-1880," ex Boudier Herb. at Farlow).

GERMANY: Leipzig, *Th. M. Fries*, 1861 (Upsala).

FRANCE: Seine, Bois de Boulogne, *Tulasne*, Sept., 1844, type of *H. argenteus* (Paris and Brit. Mus.); Vaucluse, Avignon, Bouchet, *Tulasne*, Oct., 1844 (olim *H. argenteus*, Paris).

ENGLAND: Wiltshire, Rudloe, *C. E. Broome* (Kew).

MAINE: York County, Kittery Point, *R. Thaxter 1902x*, Sept. 18, 1902 (Farlow).

CALIFORNIA: Alameda County, Berkeley, *N. L. Gardner 223;* Monterey County, Pacific Grove, *N. L. Gardner & M. B. Nichols 298* (both Univ. Cal. and Zeller).

9. HYMENOGASTER BUCHOLTZII Soehner, Krypt. Forsch. 1: 395. 1924.

Type: in Soehner Herb. but not seen by us.

Fructifications white, often spotted with pale yellow, becoming subfuscous, very firm; peridium 150–200 µ thick, fibrous without, pseudoparenchymatous within; gleba at first white, becoming violaceous mixed with fuscous at maturity, cavities very small; spores hyaline, becoming golden and fuscous at maturity, 1–several-guttulate, ellipsoid, attenuate at each end; mucro free when young, becoming involved in the exospore which becomes almost round, 20–30 × 12–18 µ, without sculpture, 19–25 × 7–10 µ.

München, Gauting, Planegg, Erharting bei Mühldorf, Germany.

10. HYMENOGASTER **pyriformis** Zeller & Dodge, sp. nov.

Fructificationes gregariae vel caespitosae, 1–2 cm. diametro metientes, pyriformes vel subglobosae, albae hypogeae, luteae vel brunneae emersae, tactu caerulescentes, "drab" vel "olive-brown" siccatae, superficie laevi vel tomentulosa; basis sterilis prominens, inferne conica; caro fracta sectave caerulescens; peridium crassum in lateribus, tenuius superne, 200–400 µ crassitudine, prosenchymaticum, superficie hyphis paucis magnis laxis; gleba grisea, caerulescens secta, fusca siccata, locellis parvis, irregularibus, e basi sterili radiantibus; septa 18–30 µ crassitudine siccata prosenchymatica; basidia cylindrica, uni- vel bispora, sterigmatibus 4–8 × 1.8–2 µ; sporae magnitudine variabiles, 12–23 × 9–11 µ, ellipsoideae vel obovoideae, rotundatae, rugis parvis, irregulariter longitudinalibus anastomosantibus, obscure brunneae. Odor terreus.

Type: in Dodge and Zeller Herbaria.

Fructifications gregarious to cespitose, 1–2 cm. in diameter, pyriform to subglobose, emersed or wholly hypogeous, white while hypogeous, yellowish-brown where exposed, turning blue when touched or bruised, drying drab to olive-brown, surface smooth to tomentulose; sterile base prominent, projecting, conical below; flesh turning blue where broken or cut; peridium thick on sides, thinner above, variable in thickness, 200–400 μ, drying 130–200 μ thick, consisting of prosenchyma, collapsing on drying, surface with a few loose large hyphae, white, turning bluish, drying hyaline; gleba grayish, turning bluish where cut, drying fuscous, cavities small, irregular, mostly radiating from the sterile base; septa drying 18–30 μ broad, of hyaline prosenchyma; basidia cylindrical, 1–2-spored, sterigmata 4–8 × 1.8–2 μ; spores extremely variable in size, 12–23 × 9–11 μ, ellipsoid to obovoid, with broadly rounded tips, slight, irregularly anastomosing longitudinal or diagonal wrinkles giving appearance of faint striations, medium dark brown. Mild earthy odor.

Gregarious or cespitose in grassy places under *Quercus agrifolia*. California. October.

CALIFORNIA: Santa Clara County, Guadaloupe Mines, *H. E. Parks 262*, in part (Univ. Cal.), *Z262*, type (Dodge and Zeller).

11. HYMENOGASTER CEREBELLUM Cavara, Fung. Longobard. Exsicc. Pugill. **3**: no. 109. 1893; Atti Ist. Bot. Pavia. II. **3**: 211–229, 324. 1894?; Rev. Myc. **16**:152–157. 1894; Sacc. Syll. Fung. **11**: 171–172. 1895.

Illustrations: Cavara, drawing accompanying type distribution, Fung. Longobard. no. 109; Atti Ist. Bot. Pavia. II. 3: *pl. 25;* Rev. Myc. **16**: *pl. 148.*

Type: distributed in Cavara, Fung. Longobard. no. 109.

Fructifications 2–3 cm. in diameter, cerebriform, white, becoming yellowish (Cavara), drying cinnamon-buff, sterile base not seen; peridium 140 μ thick, of varicose hyphae compactly interwoven, simulating pseudoparenchyma, those on the outer surface thicker-walled, growing out and enfolding soil particles; gleba rose-lilac to yellow-ochraceous, drying Argus-brown, cavities large, irregular; septa 30–40 μ thick, of slender hyphae closely interwoven; basidia clavate, approaching cylindric; spores 12–15 × 8–11 μ, brown, ovoid, approaching citriform, more or less apiculate, verrucose, with a rather closely applied utricle.

Among roots of coniferous and deciduous trees in botanical gardens. Italy and France. Spring and summer.

EXSICCATI: Cavara, Fung. Longobard. 109.

ITALY: Lombardia, Pavia, *F. Cavara*, Fung. Longobard. 109, type distribution (Mo. Bot. Gard., N. Y. Bot. Gard., and Farlow).

FRANCE: Alpes Maritimes, Antibes, *Poirault* (Farlow).

12. HYMENOGASTER **fragilis** Zeller & Dodge, sp. nov.

Fructificationes siccatae 1–2 cm. diametro metientes, subsphericae vel pyriformes, albidae vel griseae, sordidae vel "cinnamon-buff" siccatae, basis sterilis prominens (ut in *Lycoperdon*) magnis cum cavitatibus, superficie laevi, floccosa vel sericea; peridium fragilis, hyalinum vel subluteum, stuposum, homogeneum, 130–160 μ crassitudine superne, 50–100 μ crassitudine inferne; gleba siccata "pecan-brown," cavitatibus magnis; septa fragilia, hyalina, 25–40 μ crassitudine, stuposa; basidia non visa; sporae brunneae, late fusiformes vel ellipsoideae, apiculo parvo, vel obtuse subcitriformes et pedicellatae, subasperatae vel subverrucosae, 11–12 × 7–8 μ.

Type: at Farlow Herb.

Fructifications drying 1–2 cm. in diameter, subspherical or pyriform, whitish or gray, drying dirty white or cinnamon-buff; sterile base well developed, with large cavities, resembling the stipe of *Lycoperdon;* surface even, floccose or silky; peridium fragile, hyaline or slightly yellowish, stupose, homogeneous, 130–160 μ thick above, sometimes 50–100 μ thick below; gleba drying pecan-brown, with large empty cavities; septa fragile, hyaline, 25–40 μ thick, stupose; basidia not seen; spores brown, ovoid, broad-fusiform to ellipsoid or obtusely subcitriform with a small apiculus and pedicel often inequilateral, verrucose with a flaking utricle, 11–12 × 7–8 μ.

California and southern Chile. February and March.

The spores resemble those of *Arcangeliella Campbellae* but are much larger.

CALIFORNIA: *H. E. Parks 2182* (Univ. Cal).

CHILE: Magellanes, Punta Arenas, *R. Thaxter F. H. 1, 4,* type, Feb. and March, 1906 (Farlow).

13. HYMENOGASTER CITRINUS Vittadini, Monogr. Tuberac. 21. 1831; Tulasne, Ann. Sci. Nat. Bot. II. **19**: 374. 1843; Fung. Hypog. 69. 1851; Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **13**: 346. 1844; Fries, Summa Veg. Scand. 436. 1849; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 875. 1883; De

Toni in Sacc. Syll. Fung. 7: 169. 1888; Massee, Ann. Bot. 4: 45. 1889 [often cited as Monogr. Brit. Gast. 45. 1889]; Hesse, Hypog. Deutschl. 1: 112–113. 1891; Th. M. Fries, Svensk Bot. Tidskr. 3: 276. 1909; Hollós, Magyar. Földalatti Gombai, 91, 204. 1911; Th. C. E. Fries, Ark. f. Bot. $17^9$: 13. 1921; Soehner, Zeitschr. f. Pilzk. 2: 157. 1923.

*Splanchnomyces citrinus* Corda, Icones Fung. 6:43–44. 1854.

*Hymenogaster Citrus* Tulasne, Fung. Hypog. ed. 2. 74. 1853.

*Splanchnomyces Citrus* Corda, Icones Fung. 6: 43. 1854.

*Hymenogaster Pisomyces* Fries, herb. nom.

*Melanogaster Ferrarianus* de Notaris, herb. nom.

Illustrations: Berkeley, Outlines Brit. Fungol. *pl. 20, f. 2;* Corda, Icones Fung. 6: *pl. 9, f. 86, 87;* Hesse, Hypog. Deutschl. 1: *pl. 7, f. 29;* Massee, Ann. Bot. 4: *pl. 1, f. 8;* Tulasne, Ann. Sci. Nat. Bot. II. 19: *pl. 17, f. 9–10;* Fung. Hypog. *pl. 1, f. 1; pl. 10, f. 3;* Vittadini, Monogr. Tuberac. *pl. 3, f. 2; pl. 5, f. 9b.*

Type: in Broome Herb., Fries Herb., and Tulasne Herb. Type of *H. Citrus* probably England, Wiltshire, Rudloe, *C. E. Broome,* com. Berkeley but not seen by us. Type of *H. Pisomyces* collected by *E. P. Fries* in the Bot. Trädgård at Upsala, specimens in Kew and in Upsala.

Fructifications 2–4 cm. in diameter, irregularly subglobose, lemon- or golden-yellow, drying clay-color to tawny-olive, or black at maturity; surface even, silky to dull fibrillose; peridium stupose near surface, prosenchymatous, of large cells below, 80–150 μ thick, dark brown, brittle when dry; gleba yellow, then brownish when fresh, drying Prout's brown to sooty black and brittle like charcoal, cavities relatively large; septa rather broad, 60–80 μ, of compact prosenchyma; basidia 2-spored, 22–32 × 12–15 μ; spores 20–35 × 13–17 μ, broadly fusiform to obovoid, diamond-kite-shaped at maturity, apiculate, with narrow base, smooth when young, becoming coarsely verrucose at maturity, covered by a variously wrinkled utricle which is thin, brownish, but dark umbrinous at maturity.

Hypogeous, under deciduous and coniferous trees. Europe and New York. April to December.

U. S. S. R. [RUSSIA]: Kedfil Wald, *F. Bucholtz,* Aug. 3, 1909; Moskva, Mikhailovskoe, *F. Bucholtz 6b, 7a,* Aug. 25, 1910; *E. Sheremetev* (all Farlow).

SWEDEN: Uppland, Upsala, Karolinaparken, *Th. M. Fries,* 1879, Aug. 11, 1883, Sept., 1883, Sept., 1885, Oct., 1885; Botaniska Trädgård, *Th. M. Fries,* 1851, *E. P. Fries,* 1851 (sub *Octaviania Pisomyces* n. sp.,? all Upsala).

GERMANY: ex herb. Kupka, without locality (Berlin); Bayern, München, *E. Soehner 945, 995, 1025,* 1924 (Soehner); Hessen-Nassau, Kirchditmold, *R. Hesse,* Apr., 1890 (Hesse).

AUSTRIA: Wien, *Soehner 1601* (Soehner).

ITALY: Trentino, *G. Bresadola,* July, 1879 (Upsala); Lombardia, Milano, *C. Vittadini* (Brit. Mus., Upsala, and Paris); without locality, *Ferrari* (sub *Melanogaster Ferrarianus,* com. De Notaris, Curtis Herb. at Farlow).

FRANCE: Seine, Vincennes, *Tulasne* (Paris); without locality, eastern France, *L. Quélet* (Upsala).

ENGLAND: Wiltshire, Westbury, *G. H. K. Thwaites* (sub. *H. olivaceus*); Rudloe, *C. E. Broome,* 11/10, 1842; Sussex, Reigate, *C. E. Broome,* Nov., 1879 (all Kew).

NEW YORK: Ithaca, lower Forest Home path, *H. S. Jackson* (N. Y. State Coll. Agr., Cornell Univ. 9920, det *H. tener* by H. M. Fitzpatrick and H. H. Whetzel).

13a. var PALLENS Soehner, Krypt. Forsch. **1**: 397. 1924.

Type: in Soehner Herb. but not seen by us.

Differs from the typical form in fructifications being light yellow and spores sometimes almost spherical, with a long pedicel up to 12 μ, along with typical *H. citrinus* spores; spores including pedicel 25–55 × 7–14 μ.

Vicinity of München. Rare.

14. **HYMENOGASTER PRUINATUS** Hesse, Hypog. Deutschl. **1**: 113. 1891; Sacc. Syll. Fung. **11**: 170. 1895.

Illustrations: Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 31.*

Type: location unknown to us.

Fructifications the size of a hazel-nut and larger, very irregular, light yellow at first, finally becoming dark yellow and brownish; peridium 0.5 mm. thick, composed of loosely woven pseudoparenchyma of large thin-walled cells surrounded by a few hyphae, somewhat as in *H. decorus* Tul.; gleba firm, dark brown, cavities small; septa brown, fairly thick, composed of closely woven, richly septate hyphae; basidia slender, mostly 2-spored, projecting beyond the paraphyses; spores citriform, appendiculate, with short (2 μ), sharp papilla, 21–27 × 10–14 μ, exospore thin, bright, becoming dark brown, sometimes surrounded by a sheath.

In old beech woods. Hessen-Nassau, Germany. August and September.

### 15. Hymenogaster **Gilkeyae** Zeller & Dodge, sp. nov.

Fructificationes depresso-globosae vel irregulares, 1–2.5 cm. diametro metientes, albae vel albidae, ''cartridge-buff'' vel ''cream-buff'' siccatae, laeves, sericeae; basis sterilis pulvinata vel conica; peridium hyalinum, prosenchymaticum, 130–200 μ crassitudine, superficie stuposa; gleba nigro-umbrina recens, ''snuff-brown'' siccata; septa 37–56 μ crassitudine, hyalina, prosenchymatica, cellulis vesiculosis, angulis scissilia; basidia 2- vel 4-spora, sterigmatibus brevibus, crassis; sporae ovoideo-citriformes, apiculo pedicelloque prominentibus, utriculo dilacerato evanescente, episporio verrucoso, 15–22 × 10–11 μ. Odor Hamamelidis.

Type: in Univ. Cal., Dodge, and Zeller Herbaria.

Fructifications depressed-globose to irregular, 1–2.5 cm. in diameter, snow-white to grayish, drying cartridge-buff to cream-buff, smooth to silky; sterile base pulvinate to conical; peridium hyaline, homogeneous, prosenchymatous, 130–200 μ thick with a very thin stupose surface; gleba dark umber when fresh, drying snuff-brown; septa 37–56 μ thick, of hyaline prosenchyma of vesicular cells, scissile at angles; basidia 2- and 4-spored, sterigmata short, stout; spores ovoid-citriform, with prominent apiculus and pedicel, at first with utricle which sloughs ragged, leaving verrucose surface, 15–22 × 10–11 μ. Odor of musty flowers and witch-hazel.

In mixed woods and under *Aesculus* and *Quercus*. Oregon and California. November to April.

Oregon: Benton County, Corvallis, *J. L. Mielke* (Zeller 6897); Linn County, Peoria Road, *H. M. Gilkey* (Oregon State, and Zeller 2335); near Roaring River Fish Hatchery, *S. M. Zeller 8201, 8203* (Zeller).

California: Alameda County, Berkeley, *N. L. Gardner 57;* Santa Clara County, *H. E. Parks 983*, type; Alma, *H. E. Parks 162B* (com. N. L. Gardner 546); Guadaloupe, *H. E. Parks 433A*, Apr. 22, 1921; Santa Cruz County, Felton, *H. E. Parks 501;* Monterey County, Pacific Grove, *N. L. Gardner & M. B. Nichols 303* (all Univ. Cal., Dodge, and Zeller); San Mateo County, Jasper Ridge in Palo Alto, *James McMurphy 274, 282, 298* (Stanford and Zeller).

### 16. Hymenogaster **Gardneri** Zeller & Dodge, sp. nov.

Fructificationes 1–1.5 cm. diametro metientes, irregulares, rimosae, firmissimae, sordide albidae brunnescentes, ''buff-brown'' siccatae, laeves vel floccosae; peridium 80–150 μ crassitudine siccatum, hyalinum, prosenchymaticum, hyphis floccosis in superficie; gleba brunnea, solida, aquosa, locellis parvis; septa hyalina, prosen-

chymatica, 10–20 μ crassitudine siccata; basidia anguste clavata, 2–4-spora; sporae nigro-brunneae, late ellipsoideae, subfusiformes, episporio laevi, crasso, utriculoque obscuro, aspero, lacerato, rugis longitudinalibus in sporis immaturis, pedicellato, 18.5–26 × 11.5–14 μ.

Type: in Univ. Cal., Dodge, and Zeller Herbaria.

Fructifications 1–1.5 cm. in diameter, irregular in shape, checking and cracking, very firm and compact, at first dirty white, becoming brown, drying buff-brown, surface smooth to flocculent; peridium of tough, hyaline, homogeneous prosenchyma, with flocci of hyphae on the surface, drying 80–150 μ thick; gleba brown, firm, watery, cavities relatively small; septa of hyaline prosenchyma, drying 10–20 μ thick; basidia narrowly clavate, 2- and 4-spored; spores very dark brown, broad-ellipsoid, tapering to both ends, epispore smooth, thick, but with a very dark, rough, torn utricle with more or less longitudinal folds as shown by immature spores, pedicellate, 18.5–26 × 11.5–14 μ.

In clay soil under *Quercus* and *Salix*. California. March.

The type of this species, although near to *H. citrinus* and *H. olivaceus (H. decorus)*, is very distinct in the young spores, which approach the characters of *H. lycoperdineus*. Gardner's No. 279 is referred here with some doubt, since the mature spores are quite similar to those in the type of *H. Thwaitesii.*

CALIFORNIA: Alameda County, Berkeley, *N. L. Gardner 89* type, *279* (Univ. Cal., Dodge, and Zeller); San Mateo County, Palo Alto, *James McMurphy 290* (Stanford and Zeller).

17. HYMENOGASTER MUTICUS Berkeley & Broome, Ann. & Mag. Nat. Hist. II. 2: 267. 1848; Tulasne, Fung. Hypog. 65. 1851; Cooke, Handbook Brit. Fung. 1: 360. 1871; DeToni in Sacc. Syll. Fung. 7: 172. 1888; Massee, Ann. Bot. 4:42–43. 1889 [often cited as Monogr. Brit. Gast. 42–43. 1889]; Hesse, Hypog. Deutschl. 1: 118–119. 1891.

Illustrations: Massee, Ann. Bot. 4: *pl. 1, f. 20;* Tulasne, Fung. Hypog. *pl. 10, f. 7.*

Type: in Berkeley Herb. 4459, in Hooker, and in Cooke at Kew, Fries Herb. at Upsala, and fragment in Lloyd Mus.

Fructifications usually spherical, occasionally irregular, smooth becoming rimose, about 1 cm. in diameter, white, becoming dark brown; peridium 150–200 μ thick, composed of homogeneous prosenchyma, distinct from the gleba, easily separable; gleba reddish-brown to dark brown, cavities small near the peridium, larger within; septa thin, 20–40 μ thick, fibrous; basidia rather large, 2-spored; spores 18–23 × 10–15 μ, appendiculus 2 × 2 μ, usually not papillate but broadly obtuse, obovoid, deep red-brown, with a wavy-wrinkled surface.

Hypogeous. Western Europe. Early spring.

SWEDEN: Upsala, *K. A. Th. Seth,* 1891 (Upsala).

FRANCE: Alpes Maritimes, Nice, *Barla* (Farlow); *L. Quélet,* 1889 (Upsala).

ITALY: Trentino, *G. Bresadola,* May, 1888 (Upsala).

ENGLAND: Gloucestershire, Stapleton Grove, *C. E. Broome,* type (Kew, Upsala, Lloyd 0213).

18. HYMENOGASTER PILOSIUSCULUS Hesse, Hypog. Deutschl. **1**: 127. 1891; Sacc. Syll. Fung. **11**: 171. 1895.

Illustrations: Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 38.*

Type: location unknown to us.

Fructifications somewhat larger than a hazel-nut, irregular, often flattened, citron to dark yellow; peridium a strong line thick, composed of small-celled pseudoparenchyma loosely arranged, with slender hyphae next the gleba; gleba citron-yellow, cavities small and filled with spores; septa composed of slender hyphae; basidia 2-spored, fairly long and broad, paraphyses similar but septate; spores 16–26 × 4–8 μ, rounded at the apex, without a papilla, with a short slender appendiculus, yellowish, exospore wrinkled.

Under stands of *Fagus.* Hessen-Nassau, Germany. August to October.

19. HYMENOGASTER GRISEUS Vittadini, Monogr. Tuberac. 23. 1831; Tulasne, Fung. Hypog. 69. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 875. 1883; De Toni in Sacc. Syll. Fung. **7**: 170. 1888; Massee, Ann. Bot. **4**: 48. 1889 [often cited as Monogr. Brit. Gast. 48. 1889]; Hesse, Hypog. Deutschl. **1**: 131–132. 1891.

Illustrations: Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 36;* Payer, Bot. Cryptog. 114. *f. 258;* Roumeguère, Cryptog. Ill. *f. 372.*

Type: location unknown to us; however, material from Vittadini so determined in Herb. E. Fries at Upsala.

Fructifications small, 1–1.5 cm. in diameter, subglobose, not shrinking much on drying, surface white at first, drying cinnamon-buff to snuff-brown, whitish-villous to innate-fibrillose; sterile base scarcely visible; peridium 185 μ thick, densely stupose; gleba gray, soon becoming dark, drying bister; septa of thin-walled hyphae, 30–40 μ thick; basidia long, cylindric, 2-spored, sterigmata stout, 11–13 μ long; paraphyses slender, septate; spores ellipsoid, distal end obtuse and rounded, undulating surface with a clear wrinkled utricle, brown becoming black, 20–25 × 11–13 μ, pedicel 2–3 μ long, 3–4 μ in diameter. Odor of *Convallaria majalis.*

Under *Populus, Quercus,* and *Fagus.* Italy, Oregon, and Argentina.

ITALY: Trentino, *G. Bresadola,* Aug., 1886, (Upsala); Lombardia, Milano, *C. Vittadini* (Upsala).

OREGON: Benton County, Alsea Road along Greasy Creek, *H. M. Gilkey* (Oregon State, and Zeller 2802).

ARGENTINA: Buenos Aires, *R. Thaxter,* 1905, (Farlow).

20. HYMENOGASTER CAERULESCENS Soehner, Zeitschr. f. Pilzk. **1**: 6–8. 1922; E. Fischer, Veröffentl. Geobot. Inst. Rübel in Zürich **3**: 578–581. 1925.

*Hymenogaster caespitosus* Soehner, Krypt. Forsch. **1**: 396–397. 1924.

Type: in Soehner Herb.

Fructifications spherical to subspherical, small, 1–2 cm. broad, white, becoming bluish-green when bruised or touched, drying grape-green to Andover green, surface even to ruptured, fibrillose to byssoid; peridium hyaline, thin, 90–130 μ thick, of large-celled pseudoparenchyma, with a very few superficial large-celled, multi-septate hyphae; gleba white or brown when fresh, turning bluish-green when cut, drying light chalcedony with flecks of darker green or fuscous-black; septa hyaline, pseudoparenchymatous, 60–75 μ thick; basidia narrowly clavate, mostly 4-spored; spores very dark brown, 19–22 × 12–15 μ, ellipsoid with very obtuse ends, utricle with 8 longitudinal folds, apiculus slight but often apparent, pedicel often adhering, hyaline.

On wet ground or under moss in coniferous or deciduous woods. Germany and northern California. July to November.

The spores of this species are similar to those of *Gautieria*, but *H. caerulescens* lacks a columella.

GERMANY: Bayern, Mühldorf, *E. Soehner 497*, type, *613* (Soehner).
CALIFORNIA: Humboldt Co., Trinidad, *H. E. Parks 4622* (Univ. Cal. and Zeller).

21. HYMENOGASTER CINEREUS Hesse, Hypog. Deutschl. **1**: 132. 1891; Sacc. Syll. Fung. **11**: 171. 1895.

Illustrations: Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 37.*

Type: location unknown to us.

Fructifications the size of a horse-bean, somewhat ragged, irregular, snow-white becoming yellowish when touched; peridium scarcely a line thick, composed of long, slender, septate hyphae; gleba ashy; basidia narrow-cylindrical, 2-spored, projecting beyond the septate paraphyses; spores fusiform, reddish-yellow, 21–30 × 9–12 μ, with a short, hyaline papilla and an appendiculus 1 × 1 μ.

Under old trees of *Fagus* and *Quercus*. Hessen-Nassau, Germany. August to November.

22. HYMENOGASTER **Boozeri** Zeller & Dodge, sp. nov.

Fructificationes 1–1.5 cm. diametro metientes, depresso-globosae, albidae tactu brunnescentes, "bister" siccatae, laeves; peridium homogeneum, hyalinum, prosenchymaticum extero obscurius densiusque, 120–160 μ crassitudine (100–130 μ siccatum); gleba subalbida vel griseo-brunnea, "cinnamon-buff" siccata, locellis magnis; septa 20–35 μ crassitudine, prosenchymatica; basidia clavata, 18–25 × 6–8 μ, bispora, sterigmatibus brevissimis, 2–3 μ longitudine, crassis; sporae maturae, 24–30 × 13–15 μ, obscure brunneae, ovoideo-ellipsoideae vel late fusiformes, episporio crasso, utriculo longitudinaliter rugoso, rimoso, sporae juniores elongatae, cylindricae, lanceolatae vel anguste fusiformes, 26–40 × 7.4–10.5 μ, laeves. Odor caseosus.

Type: in Oregon State, Dodge, and Zeller Herbaria.

Fructifications 1–1.5 cm. in diameter, depressed-globose, whitish, staining brownish where touched, drying bister, surface smooth; peridium composed of homogeneous, hyaline prosenchyma with a darker rind of a more compact prosenchyma, 120–160 μ thick when fresh, drying 100–130 μ; gleba with large cavities, almost white to grayish-brown, drying cinnamon-buff; septa 20–35 μ thick, prosenchymatous; basidia clavate, 18–25 × 6–8 μ, 2-spored, sterile basidia common as figured by Tulasne for *H. citrinus,* sterigmata very short (about 2–3 μ long), stout; mature spores 24–30 × 13–15 μ, dark brown, ovoid-ellipsoid to broadly fusiform, thick epispore with a longitudinally wrinkled utricle which flakes off, immature spores long-cylindrical to lanceolate or narrowly fusiform, 26–40 × 7.4–10.5 μ, smooth. Odor like cheese (fermentation).

Under *Quercus.* Oregon. April.

This species resembles *H. vulgaris* in color of the fructification and utricle of the spores, but differs in several other respects.

OREGON: Benton County, Corvallis, *L. M. Boozer,* type (Oregon State, Dodge, and Zeller 2286).

23. HYMENOGASTER NIVEUS Vittadini, Monogr. Tuberac. 24. 1831; Tulasne, Fung. Hypog. 65. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 876. 1883; DeToni in Sacc. Syll. Fung. **7**: 172. 1888; Soehner, Hedwigia **64**: 192–202. 1923.

Illustrations: Fourquignon, Champ. Supér. 123. *f. 93;* Soehner, Hedwigia **64**: 196; Vittadini, Monogr. Tuberac. *pl. 4, f. 9.*

Type: material from Vittadini in Berk. Herb. at Kew, and in Lloyd Mus.

Fructifications about 1 cm. in diameter, subspherical, drying somewhat irregular, snow-white, reddening to the touch when fresh, drying ochraceous-tawny to buckthorn-brown or even darker, sterile base evident; peridium 300–320 μ thick, drying 60–110 μ, composed of compactly woven hyphae (prosenchyma in islands) with larger varicose hyphae 5–6 μ in diameter; gleba light fuliginous, becoming very dark brown, cavities large; septa thin, 15–20 μ thick, composed of slender, compact, gelified hyphae; basidia 2-spored, pyriform, 8–9 × 5–6 μ, projecting above the septa, not numerous and early collapsing, so that the sterigmata appear to arise directly from the septal hyphae; spores rather large, warted, short-pedicellate, ovoid- to ellipsoid-citriform, with short, blunt, hyaline apiculus, 15–18.5 × 9.5–11.5 μ. Odor of *Pelargonium.*

Hypogeous under deciduous and coniferous trees. Europe and North America. May to September.

ITALY: Lombardia, Milano, *C. Vittadini;* Trentino, *G. Bresadola* (both Kew).
GERMANY: Bayern, München Süd, *E. Soehner 843* (Soehner).
ENGLAND: *C. E. Broome* (Lloyd Mus. 0222).
CANADA: Quebec, Little Métis, *E. C. Jeffrey* (Farlow).
MICHIGAN: Ann Arbor, *C. H. Kauffman 21* (Univ. Mich. and Zeller).
OREGON: Benton County, Corvallis, *S. M. Zeller 8197* (Zeller).

24. HYMENOGASTER SPICTENSIS Patouillard, Bull. Soc. Myc. France **30**: 350–351. 1914; Trotter in Sacc. Syll. Fung. **23**: 599. 1925.

Type: no specimen cited as type by Patouillard, but all material so determined by him in his herbarium at the Farlow Herb. is this species.

Fructifications from about the size of a pea to that of a filbert, spherical, rarely irregular, always a little depressed at the base, pure white, becoming grayish or rufous when touched, brown in alcohol; peridium thin, drying 90–100 μ thick, composed of elongated cells, more slender toward the periphery, from which is derived the granular hyphae (2–5 μ thick); gleba white, cream, rufous, and finally deep chestnut, sterile base absent; basidia cylindric, 25–35 × 4–10 μ, with four short sterigmata; spores ferruginous-yellow, broadly fusiform to obovoid, narrow, obtuse at the apex and often appendiculate below, epispore verruculose and wrinkled, 15–22 × 7–10 μ, occasionally as short as 12 μ or as long as 25 μ, 2–3-guttulate.

Under *Quercus, Fagus, Betula.* Central Europe. June to December.

U. S. S. R. [RUSSIA]: Moskva, Mikhailovskoe, *F. Bucholtz,* Aug. 26, 1907; Sekirino, *F. Bucholtz & N. Mossolov,* Aug. 23, 1907; Senjkino, *F. Bucholtz,* July 26, 1906; Shebaly forest near Mikhailovskoe, *N. Mossolov,* July 24, 1906; *F. Bucholtz,* July 26, 1906; Voronovo, *F. Bucholtz,* Aug. 22, 1907 (all Farlow).

GERMANY: Bayern, München, *E. Soehner 942* (sub *H. Rehsteineri??,* Soehner).

ITALY: Trentino, *G. Bresadola,* July, 1880, Dec., 1888 (sub *H. niveus* Vitt., Upsala).

AUSTRIA: Vorarlberg, Feldkirch, *F. Theissen* (Farlow).

FRANCE: *L. Quélet* (Upsala); Barezian, *N. Patouillard*, Oct., 1913, (Farlow); Lepinay, *N. Patouillard*, Aug., 1912, Aug., 1913 (Farlow); Doubs, Hérimoncourt, *L. Quélet* (sub *H. niveus*, Upsala); Belfort, Delle, *L. Quélet* (sub *H. lycoperdineus*, Upsala); Jura, Joye de Buron, *N. Patouillard*, Oct., 1906 (Farlow).

### 25. HYMENOGASTER **reticulatus** Zeller & Dodge, sp. nov.

Fructificationes subsphericae, ad 1 cm. diametro metientes, umbonatae, pallidae vel flavo-brunneae, superficie laevi spongiosa; peridium 70–120 μ crassitudine siccatum, hyphis tenuissimis, laxe implicatis, stuposis; gleba sordide brunneo-albida, ''cinnamon-buff'' vel ''tawny-olive'' siccata, fragilis, locellis parvis, irregularibus; septa scissilia, 25–30 μ crassitudine, hyphis laxe implicatis; basidia anguste clavata, bispora, sterigmatibus tenuibus, brevibus; sporae obscure brunneae, late citriformes, apiculo prominente, laevi, episporio reticulate foveolato, 14.5–16 (–18.5) × 9.6–11 (–11.5) μ.

Type: in Cleland, Dodge, and Zeller Herbaria.

Fructifications subspherical, about 1 cm. in diameter, with a small umbo, pallid with yellowish-brown tints, drying cinnamon-buff to tawny-olive, surface smooth but spongy; peridium about 70–120 μ thick (dry), of very slender loosely woven stupose hyphae, hyaline to citrine; gleba dirty brownish-white, drying cinnamon to tawny-olive, fragile, cavities irregular, relatively small; septa hyaline, scissile, 25–30 μ thick, of rather loosely interwoven hyphae; basidia 2-spored, slender, clavate, sterigmata slender, short; spores dark brown, broadly citriform with a prominent smooth apiculus, 14.5–16 (–18.5) × 9.6–11 (–11.5) μ, exospore reticulate-pitted, pits averaging 2 μ broad.

Hypogeous. South Australia. April.

The spores of this species are evenly and beautifully reticulate-pitted, the markings strikingly distinct from those of other species.

In the type collection the surface of the peridium is overgrown by a mycelium of yellowish, clear hyphae about 4 μ in diameter, having clamp connections and clavate tips about 7–8 μ broad. It could not be determined whether this mycelium is organically connected with *H. reticulatus*.

AUSTRALIA: South Australia National Park, *J. B. Cleland 6*, Apr. 29, 1924, type (Dodge and Zeller).

### 26. HYMENOGASTER **atratus** (Rodway) Zeller & Dodge, comb. nov.

*Hysterangium atratum* Rodway, Papers & Proc. Roy. Soc. Tasmania **1919**: 112. 1920.

Type: A specimen without locality data but marked "co-type 1265" has been kindly communicated to us by Rodway.

Fructifications subspherical, 1.5–2 cm. in diameter, viscid, dark brown; peridium thin but tough, fleshy, 60–120 μ thick, pseudoparenchymatous; gleba dark brown, cavities small; septa of hyaline prosenchyma, 15–20 μ thick; spores dark brown, nearly spherical to broadly ellipsoidal, 11.5–15 × 10–11.5 μ, minutely alveolate, short-pedicellate, the utricle or alveolae almost hyaline.

Hypogeous. Australia and Tasmania. July.

AUSTRALIA: S. Australia National Park, *J. B. Cleland 16* (Dodge and Zeller); Queensland, Rockhampton, *A. Thozet* (sub. *H. Klotzschii,* Kew).

TASMANIA: [Mt. Nelson Range], *L. Rodway 1123, 1265* (Dodge and Zeller).

27. HYMENOGASTER **mutabilis** (Soehner) Zeller & Dodge, comb. nov.

*Hymenogaster tener* var. *mutabilis* Soehner, Hedwigia **64**: 200. 1923.

Illustrations: Soehner, Hedwigia **64**: 196.

Type: in Soehner Herb.

Fructifications 1–3 cm. in diameter, subglobose, whitish to yellowish when fresh, drying fuscous, surface smooth to soft-silky; peridium 75–100 μ thick, loose-stupose with inclusions of many hyaline, diamond-shaped crystals; sterile base distinct in young specimens, pulvinate; gleba yellowish, with reddish, violet, red-brown to ochraceous tones, drying Verona brown, cavities small; septa prosenchymatous, 15–25 μ thick; basidia 2-spored; spores dark brown, broadly ellipsoid to citriform, short-pedicellate, mostly with very small apiculus, wrinkled to verrucose surface with a closely applied utricle, 12–15 × 9–11 μ.

Hypogeous in rich soil in deciduous woods. Germany and North America. July to September.

GERMANY: Bayern, München, Englische Gärten, *E. Soehner 703,* type (Soehner).

CANADA: Manitoba, *G. R. Bisby* (Zeller 7462).

NEW YORK: Onandaga County, Syracuse, *A. H. Povah 832* (Farlow).

28. HYMENOGASTER **McMurphyi** Zeller & Dodge, sp. nov.

Fructificationes oblate sphaeroideae vel irregulares, 1–1.5 cm. diametro metientes, luteae, obscuriores siccatae, superficie fibrosa, subaspera; basis sterilis parva, pulvinata; peridium 120–180 μ (55–100 μ siccatum) crassitudine, luteum, extus stuposum, intus laxe prosenchymaticum; gleba lutea vel "snuff-brown" ("bone-brown" siccata post conservationem); septa 24–32 μ inter hymenia, hyphis luteis laxe contexta, scissilia in angulis; basidia late clavata, tri- vel tetraspora, sterigmatibus tenuissimis, 5–7 μ longitudine, hyalina; sporae luteae, late ovoideae, insuper rotundatae, saepe pedicellatae, episporio crasso, tenuibus cum rugis brevibus, uniguttulatae, 12–13(–14.5) × 9.5–11(–14) μ.

Type: in Dudley Herb. at Stanford, Zeller and Dodge Herbaria.

Fructifications oblate-spheroidal to irregular, about 1–1.5 cm. in diameter, yellow, drying darker, surface fibrous-roughened; sterile base slight, pulvinate; peridium 120–180 μ (drying 55–100 μ) thick, yellow, stupose without, loosely prosenchymatous within; gleba yellow, then snuff-brown (drying bone-brown after preservation); septa 24–32 μ between hymenia, of loosely interwoven yellowish hyphae, scissile at the angles; basidia hyaline, broadly clavate, 3–4-spored with very slender sterigmata 5–7 μ long; spores yellow, broadly ovoid, rounded above, often pedicellate, exospore thick, sculptured by small, short ridges, uniguttulate, 12–13(–14.5) × 9.5–11(–14) μ.

In sandy soil, 7–10 cm. beneath the surface, under *Fraxinus oregana* and *Quercus agrifolia*. California. February and March.

CALIFORNIA: San Mateo County, Palo Alto, banks of Los Trancos Creek, near Stanford University, *James McMurphy 284, 292* type (Stanford, Zeller, and Dodge).

29. HYMENOGASTER DISCIFORMIS Hesse, Hypog. Deutschl. **1**: 128. 1891; Sacc. Syll. Fung. **11**: 171. 1895.

Type: location unknown to us.

Fructifications disciform, the size of a Bohemian "Hellerlinse" lentil, yellowish-white to cream-color; peridium thin, composed of floccose, swollen hyphae as in septa; gleba gray-white, becoming cream-color; basidia short, narrow-cylindrical, 2-spored; spores 12–16 × 5–7 μ, not apiculate, with a very short but fairly broad pedicel, ellipsoid, exospore wrinkled, brown-yellow.

In young woods of *Fagus* and *Quercus*. Hessen-Nassau, Germany. August to October.

30. Hymenogaster minusculus Soehner, Krypt. Forsch. **1:** 397. 1924.

Type: in Soehner Herb. but not seen by us.

Fructifications snow-white, becoming subfuscous, smooth, scarcely tuberous, up to 1 cm. in diameter, compact; peridium 120 μ thick; gleba at first white, then bay and inclining to reddish or lurid, cavities very small; basidia 2–4-spored, clavate, 20 × 9 μ; spores grayish-yellow, fusiform, 12–16 μ (rarely up to 20–25 μ) long, smaller spores 10 × 4–5 μ, not rare, exospore at first smooth, later slightly roughened by small furrows, utricle [? second membrane] absent.

Near München, Schleissheimer Schlosspark, Grünwald and Kaufbeuren in Schwaben.

Spores may vary between 7 and 25 μ in length in same fructification.

31. Hymenogaster verrucosus Bucholtz, Hedwigia **40:** 319. 1901; Материалы къ морфологіи и систематикѣ подземныхъ грибовъ . . . Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ с. Михайловскомъ Московской Губ. 158. 1902 [sometimes cited as Beitr. Morph. Syst. Hypog. ]; Ann. Myc. **1:** 171. 1903; Sacc. & D. Sacc. in Sacc. Syll. Fung. **17:** 240. 1905.

*Hymenogaster Rehsteineri* Bucholtz, Hedwigia **40:** 318–319. 1901; *l. c.* 156. 1902; Ann. Myc. **1:** 171. 1903; Sacc. & D. Sacc. Syll. Fung. **17:** 239–240. 1905.

*?Hymenogaster decorus* Rehsteiner, Bot. Zeit. **50:** 764–771. 1892.—*not H. decorus* Tulasne, Ann. Sci. Nat. Bot. II. **19:** 374. 1843.

*Hymenogaster olivaceus* f. *montana* Soehner, herb. nom.

Illustrations: Bucholtz, Материалы къ морфологіи и систематикѣ подземныхъ грибовъ . . . Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ с. Михайловскомъ Московской Губ. **1:** *pl. 3, f. 18, 19;* Ann. Myc. **1:** *pl. 5, f. 18–20;* ?Rehsteiner, Bot. Zeit. **50:** *pl. 10, f. 1–6.*

Type: of *H. verrucosus* and of *H. Rehsteineri* in Farlow Herb. at Harvard Univ., and in Berlin. The type of *H. olivaceus* f. *montana* in Soehner Herb. and Dodge Herb.

Fructifications irregular, spherical to subclavate, about 1.2 cm. in diameter, drying to 3–4 mm., light gray, then yellowish, drying drab, very hard; sterile base present; peridium 80–130 μ thick, composed of septate, compact hyphae which simulate prosenchyma; gleba brown, drying fuscous-black, cavities irregular, radiating from the base; septa yellowish, composed of loosely woven, parallel hyphae, with some vascular hyphae which stain blue with iodine; basidia 2-spored; spores ellipsoidal, broad at the ends, young spores obovoid to cylindrical, slightly apiculate, appendiculate, guttulate, 17–23 × 10–12.5 μ, epispore irregularly rugose-sinuose, yellow-brown, warts 0.5 μ high.

Under *Fagus, Tilia,* and *Picea.* Russia and mountains of Central Europe. April to August.

U. S. S. R. [Russia]: Moskva, Mikhailovskoe, *F. Bucholtz*, Aug. 8, 1899, Aug. 11, 1899, type of *H. Rehsteineri*, Aug., 1899, type of *H. verrucosus*, June 27, 1906, Aug. 25, 1907, July 22, 1910, Aug. 25, 1910, *4a, 4b, 5b* in part; *N. Mossolov*, Aug. 9, 1906; Senjkino, *F. Bucholtz*, July 28, 1906; Jasovka, *F. Bucholtz*, Apr. 24, 1907; Krasnaia Pachra, *F. Bucholtz*, July 29, 1907 (all Farlow).

Italy: Trentino, *G. Bresadola* (Upsala).

Germany: ?Bayern, Eddenberg Tusabeth, *E. Soehner 1035* (sub. *H. olivaceus* f. *montana* Soehner, herb. nom., Soehner).

France: Belfort, Delle, *L. Quélet* (sub. *H. pallidus*, Upsala).

32. Hymenogaster lilacinus Tulasne, Ann. Sci. Nat. Bot. II. **19**: 374. 1843; DeToni in Sacc. Syll. Fung. **7**: 170–171. 1888; Hesse, Hypog. Deutschl. **1**: 116–117. 1891; Hollós, Magyar. Földalatti Gombai, 92–93, 205. 1911; Soehner, Zeitschr. f. Pilzk. **2**: 158. 1923; ?Verwoerd, S. Afr. Jour. Sci. **22**: 166. 1925.—*not* Berkeley, Brit. Fung. no. 305.

Illustrations: Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 33;* Tulasne, Fung. Hypog. *pl. 1, f. 2; pl. 10, f. 8.*

Type: in Tulasne Herb. at Paris and a fragment in Lloyd Mus. labeled "ex Tul. at Kew."

Fructifications spherical to irregular, silky, shining white, becoming dark gray; sterile base small, dirty white, branching; peridium thin, silky, shining white, becoming brown in air, drying submembranaceous, composed of thin-walled prosenchyma, fibrous next gleba, not separable; gleba lilac-colored, becoming fuliginous; septa golden-yellow, composed of slender hyphae; basidia 2-spored, sterigmata 11 μ long; spores broadly ovoid to subacute ovoid-ellipsoid, obtuse or obtusely apiculate, nearly smooth but with somewhat wrinkled utricle, 18–24 × 12–14 μ, guttulate.

Known to us only from the type locality.

FRANCE: Seine, Vincennes, *Tulasne*, Oct., 1843 (Paris, and fragment Lloyd Mus.).

33. HYMENOGASTER EURYSPORUS Soehner, Krypt. Forsch. **1**: 296. 1924.

Type: in Soehner Herb. but not seen by us.

Fructifications ashy, later subfuscous and blackening, ovoid to spherical, floccose, the size of a chestnut; peridium very thin, composed of gelatinous hyphae; gleba whitish, yellowish, then fuscous on a cadmium-yellow background, deeper yellow in places, cavities very small; basidia clavate, 1–4-, mostly 2–3-spored, 30–40 × 10–12 μ; spores spherical at first, then broadly ovoid, without apiculus; exospore saccate, at first distended, later collapsed in transverse section, irregularly 3–6-angled, sculpturing 2–4 μ thick, pedicel 2.5–5 μ long; spores 18–25 μ long, with exospore 20–30 ×15–20 μ; ratio of length to breadth 4/3, at first deep bay then almost black.

In oak woods. Planegg-Gauting, Germany.

34. HYMENOGASTER OLIVACEUS Vittadini, Monogr. Tuberac. 24. 1831; Tulasne, Ann. Sci. Nat. Bot. II. **19**: 374. 1843; Fung. Hypog. 69. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 876. 1883; DeToni in Sacc. Syll. Fung. **7**: 172. 1888; Massee, Ann. Bot. **4**: 45–46. 1889 [often cited as Monogr. Brit. Gast. 45–46. 1889]; Hesse, Hypog. Deutschl. **1**: 126–127. 1891.

*Splanchnomyces Cordaeanus* Zobel in Corda, Icones Fung. **6**: 42. 1854.

*Splanchnomyces olivaceus* Corda, Icones Fung. **6**: 44. 1854.

*Splanchnomyces Broomeanus* Corda, Icones Fung. **6**: *pl. 13, f. 107.* 1854 *(nomen nudum).*

*Hymenogaster olivaceus* var. *modestus* Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **18**: 74. 1846; Tulasne, Fung. Hypog. 71. 1851.

*Hymenogaster decorus* Tulasne, Ann. Sci. Nat. Bot. II. **19**: 374. 1843; Fung. Hypog. 65. 1851; Cooke, Handbook Brit. Fung. **1**: 360–361. 1871; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 876. 1883; DeToni in Sacc. Syll. Fung. **7**: 169–170. 1888; Massee, Ann. Bot. **4**: 43–44. 1889 [often cited as Monogr. Brit. Gast. 43–44. 1889]; Hesse, Hypog. Deutschl. **1**: 115–116. 1891; Hollós, Magyar. Földalatti Gombai, 92, 205. 1911; Soehner, Zeitschr. f. Pilzk. **2**: 158. 1923.

*Hymenogaster pallidus* Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **18**: 74. 1846; Tulasne, Fung. Hypog. 68. 1851; Cooke, Handbook Brit. Fung. **1**: 361. 1871; DeToni in Sacc. Syll. Fung. **7**: 173. 1888; Hesse, Hypog. Deutschl. **1**: 131. 1891.

*Hymenogaster calosporus* Tulasne, Fung. Hypog. 70. 1851; DeToni in Sacc. Syll. Fung. **7**: 169. 1888; Hesse, Hypog. Deutschl. **1**: 129–130. 1891; Th. M. Fries, Svensk Bot. Tidskr. **3**: 278–279. 1909; Th. C. E. Fries, Ark. f. Bot. **17**$^{9}$: 14. 1921; Soehner, Zeitschr. f. Pilzk. **2**: 158. 1923.

Illustrations: Bucholtz, Ber. Deut. Bot. Ges. **15**: *pl. 6, f. 10–13;* Corda, Icones Fung. **6**: *pl. 8, f. 80; pl. 13, f. 107;* Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 32, 34;* Massee, Ann. Bot. **4**: *pl. 1, f. 15–18;* Tulasne, Fung. Hypog. *pl. 10, f. 4, 9;* Vittadini, Monogr. Tuberac. *pl. 3, f. 5; pl. 5, f. 5, f. 9c.*

Type: material in Broome Herb., Berkeley Herb., and Fries Herb. Type of *H. decorus* was not found, but "France, Seine, Vincennes, *Tulasne,* Oct., 1845" is in Tulasne Herb., Berkeley Herb., and Broome Herb. and represents very mature specimens. The type of *H. pallidus* (England, Northamptonshire, Cotterstock, *M. J. Berkeley*) is found at Kew, with a small fragment showing spores only, in Paris, and in Lloyd Mus. The type of *H. calosporus* (France: Seine, Vincennes, Coteau de Beauté, *Tulasne,* Oct., 1845) is found in Paris, with one small specimen in Berkeley Herb. at Kew, and represents very young specimens.

Fructifications up to 4 cm. in diameter, subglobose to irregular, pallid, becoming dirty brown, drying bister to fuscous, surface smooth to innate-fibrillose, often rupturing deep into the gleba; peridium 75–150 $\mu$ thick, homogeneous, of large, thin-walled, varicose hyphae; gleba mottled tawny and white, becoming dirty brown, drying snuff-brown to bone-brown, cavities irregular, medium small; septa 20–30 $\mu$ thick, hyaline, of gelified interwoven hyphae; basidia slender, cylindrical, 2-spored; spores smooth when young, covered with a clear, more or less closely applied utricle, obovoid-lanceolate with a cylindrical or capitate apiculus, prominent claw-like pedicel, 29–42 × 11–14 $\mu$, light yellowish-brown, guttulate with prominent epispore, mature spores dark ellipsoid with rounded ends, with a loose, much-wrinkled utricle, guttulate with a prominent epispore, 19–29 × 12–14 $\mu$.

Hypogeous under deciduous or coniferous trees. Europe and the Pacific Coast of the United States. April to January.

The long-standing concept of lanceolate spores in *H. olivaceus, H. calosporus,* and *H. pallidus* represents the immature stage of spores of *H. olivaceus,* and the broad, oblong spores of *H. decorus* as illustrated by Tulasne represent the mature stage of spores of *H. olivaceus.* In several cases from widely distributed localities, typical spores of *H. calosporus* were observed to be associated with typical spores of *H. decorus* in the same fructification, even in the same glebal cavities. As the spores mature they become shorter, the apiculus shrivels and disappears, while the utricle becomes roughly wrinkled and darker as the spore contracts.

U. S. S. R. [Russia]: Moskva, Mikhailovskoe, *F. Bucholtz,* July 22, 1906, Aug. 21, 1907, *6A,* Aug. 25, 1910; *K. P. Sheremetev,* Aug. 24, 1906 (all sub *H. verrucosa,* Farlow); Ukraine [near Kharkov], *B. M. Czernaiev* (sub *H. vulgaris,* Kew).

Lithuania: Kaunas [Kovno], *Domradsky,* Aug., 1904 (Farlow).

Sweden: Uppland, Upsala, *E. Fries* (sub *Octaviania Pisomyces,* Kew); Karolinaparken, *Th. M. Fries,* Aug., 1883, Aug. 19, 1883; Botaniska Trädgård, *Th. C. E. Fries,* Aug., 1889, Jan. 20, 1906 (all Upsala).

Germany: Bayern, München, *E. Soehner 1025* (Soehner); Hessen-Nassau, Kirchditmold, *R. Hesse,* Apr., 1890 (Hesse).

Italy: Trentino, *G. Bresadola,* Aug., 1882 (Upsala); Lombardia, Milano, *C. Vittadini* (Brit. Mus. and Upsala).

France: Seine, Vincennes, Coteau de Beauté, *Tulasne,* type of *H. calosporus* and type of *H. decorus* (Brit. Mus. and Paris).

England: Essex, Audley End, *G. E. Leafe* (Kew); Epping Forest, [*C. E. Broome?,* ex Broome Hb. in Currey Hb., Brit. Mus.]; Norfolk, [Kings Lynn?], *C. B. Plowright*, Nov., 1879, (Brit. Mus.); Northampton, Cotterstock, *M. J. Berkeley*, type of *H. pallidus* (Kew); Rushton, *M. J. Berkeley*, Aug. 19, 1848 (Kew); Wiltshire, Bowood, *C. E. Broome*, Oct. 4, 1843 (Brit. Mus.); Hartham Park, *C. E. Broome*, 1845, type of *H. citrinus* var. *modestus* (Brit. Mus.); Oct. 29, 1845 (Kew); Rudloe, *C. E. Broome*, May 17, 1843 (dist. as *H. citrinus* Berkeley, Brit. Fung., 284), May, 1843 (dist. as *H. populetorum*, *Ibid.*, 304 [or perhaps these came from Lucknam, May, 1843, as this set was issued without localities] Brit. Mus., etc.); *C. E. Broome*, May, 1848 (Brit. Mus.); Castle Coombe, *C. E. Broome*, Nov., 1843 (Brit. Mus); ?Gloucester, Blaize Castle [*C. E. Broome*], Nov. 17, 1867 (Brit. Mus.); Bedminster Down near Bristol, *C. E. Broome 309* (J. W. Bailey Herb. at Brown Univ.); near Wootton under Edge, *C. E. Broome*, Oct. 26, 1882 (Brit. Mus.); Southmead near Bristol, *G. H. K. Thwaites*, Sept. 4, 1845 (Brit. Mus.); Tan Pits near Bristol, *C. E. Broome*, Oct. 14, 1847 (Brit. Mus.); near Bristol, *C. E. Broome*, Sept. 11, 1845 (J. W. Bailey Herb. at Brown Univ.); Somerset, Batheaston, *C. E. Broome*, Dec., 1858 (sub *H. citrinus* var. *modestus*, Brit. Mus.); N. Wootton, *C. E. Broome*, Aug., 1880 (Brit. Mus).

OREGON: Benton County, Corvallis, *L. M. Boozer 37* (Oregon State 5829); Linn County, *S. M. Zeller 2589* (Zeller).

CALIFORNIA: Alameda County, Berkeley, *N. L. Gardner 222, 253;* Marin County, Ross Valley, toward base of Eldredge Grade on Mt. Tamalpais, *W. A. Setchell & C. C. Dobie* (com. N. L. Gardner 9); Santa Cruz County, Felton Big Trees, *H. E. Parks 503* (all Univ. Cal. and Zeller).

35. HYMENOGASTER VULGARIS Tulasne in Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **18**: 74. 1846; Fung. Hypog. 67. 1851; DeToni in Sacc. Syll. Fung. **7**: 175. 1888; Massee, Ann. Bot. **4**: 44. 1889 [often cited as Monogr. Brit. Gast. 44. 1889]; Th. M. Fries, Svensk Bot. Tidskr. **3**: 276–278. 1909; Hollós, Magyar. Földalatti Gombai, 91–92, 204–205. 1911; Th. C. E. Fries, Ark. f. Bot. **17**$^{9}$: 14. 1921; Soehner, Zeitschr. f. Pilzk. **2**: 158. 1923.—*not* Hesse, Hypog. Deutschl. **1**: 114–115. 1891.

*Rhizopogon albus* Fries, Syst. Myc. **2**: 293–294. 1823, excl. syn.

*Hymenogaster albus* Fries, Summa Veg. Scand. **2**: 436. 1849.—*not* Berk. & Broome, Ann. & Mag. Nat. Hist. I. **13**: 349. 1844.

*Hymenogaster griseus* Tulasne, Ann. Sci. Nat. Bot. II. **19**: 374. 1843.—*not* Vittadini, Monogr. Tuberac. 23. 1831.

*Splanchnomyces Tulasneanus* Zobel in Corda, Icones Fung. **6**: 43. 1854.

*Hymenogaster ? campester* Becker, Natur **35**: 355. 1886.

*Hysterangium australe* Spegazzini, Anal. Soc. Cient. Arg.

**11**: 242–243. 1881 [often cited as Fung. Arg. **4**: 94. 1881]; DeToni in Sacc. Syll. Fung. **7**: 157–158. 1888.

*Hymenogaster australis* Spegazzini, Anal. Soc. Cient. Arg. **29**: —. 1887 [reprinted as Truf. Arg. 6–8. 1887]; Rev. Myc. **10**: 107. 1888; Lloyd, Myc. Notes 66: 1120. 1922.

*Hymenogaster limosus* Hesse, Hypog. Deutschl. **1**: 133. 1891; Sacc. Syll. Fung. **11**: 171. 1895.

*Hymenogaster tener* var. *arbuticola* P. Hennings, Verh. Bot. Ver. Prov. Brandenburg **40**: 146. 1898; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 254. 1902; Soehner, Hedwigia **64**: 200. 1923.

*Hymenogaster arenarius* forma *austriacus* Bucholtz, herb. nom.

Illustrations: Bucholtz, Материалы къ морфологіи и систематикѣ подземныхъ грибовъ . . . Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. **1**: *pl. 4, f. 26;* Corda, Icones Fung. **6**: *pl. 13, f. 108; pl. 8, f. 84;* Hennings, Verh. Bot. Ver. Prov. Brandenburg **40**: *pl. 1, f. 19;* Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 42;* Tulasne, Ann. Sci. Nat. Bot. II. **19**: *pl. 17, f. 1–3;* Fung. Hypog. *pl. 10, f. 10.*

Type: no specimen designated by Tulasne. "France, Seine, Bois de Boulogne, *Tulasne*" in Paris and in Broome Herb. may be considered the type. *Hymenogaster campester* based on "Pilsnitz near Breslau, *L. Becker,* 18 Mai, 1893" in Bot. Mus. Berlin. *Hysterangium australe* and *Hymenogaster australis* based on "Boca de Riachuelo, Argentina, *C. Spegazzini,* May and July, 1881," fragment in N. Y. Bot. Gard. Herb.

The type of *H. limosus* Hesse has not been seen by us but is stated by E. Soehner to be the same as *H. campester.* No specimen of *H. tener* var. *arbuticola* has been designated as the type, there being eight specimens in Berlin which were all in Hennings' collection before he described the variety. Five of these were studied, and all seem to be stages in the development of *H. vulgaris.* The only possible specimen which could be considered the type of *Rhizopogon albus* Fr. is "Skåne, *E. Fries*" at Upsala and in Berkeley Herb. which may not have been collected until years after the description was written, as Fries states that it was described from living material.

Fructifications spherical to costate-sulcate and irregular, about the size of a filbert, white, becoming dirty white; sterile base often prominent; peridium about ½ mm. thick, drying 85–120 μ, separable with difficulty, smooth, silky, composed of compact hyphae; gleba white, becoming lilac, fuscous, dark brown, and often black, cavities variable in shape, empty; septa 40–45 μ thick, highly gelified; basidia cylindrical, 2-spored; spores oblong to fusiform, acute at apex, attenuate toward base, pale fuscous-yellow, slightly roughened, utricle longitudinally diagonally wrinkled, 22–33 × 9–14.8 μ.

Under moss in woods. Europe and North and South America. Spring and summer.

U. S. S. R. [RUSSIA]: Moskva, Mikhailovskoe, *K. P. Sheremetev*, Aug. 9, 1906; *E. Sheremetev*, Aug. 12; *F. Bucholtz, 8a*, Aug. 23, 1907, Aug. 25, 1910; road to Pleskovo, *F. Bucholtz*, July 29, 1906, Aug. 20, 1907, Aug. 28, 1907; Binderwirt b. d. Rasalpi, *F. Bucholtz*, June 23, 1905 (all Farlow).

FINLAND: Mustiala, *P. A. Karsten 484*, 1866–1867, distributed as Fung. Fenn., 484.

SWEDEN: Uppland, Enköping, Lidehäll, *C. J. Cederström*, Sept. 9, 1889 (Upsala); *E. Nyman*, Sept. 10, 1891, Skåne, *E. Fries* (Upsala, Kew).

AUSTRIA: between Prein and Simmering over the Eselbachsgrabern, *F. Bucholtz, 49, 50* (sub *H. arenarius* f. *austriacus* Bucholtz, von Hoehnel Herb. at Farlow).

GERMANY: Berlin, Botanischer Garten, *P. Hennings*, May 15, 1889, April 13, 1891, May 22, 1891, April 5, 1893 (all sub *H. tener* var. *arbuticola* Hennings, type not designated in Berlin); Bayern, München, *E. Soehner*, July 6, 1925 (Soehner); Sendling, *E. Soehner, 1020, 1021, 1022, 1023* (Soehner); Pilsnitz near Breslau, *L. Becker*, type of *H. campester* (Berlin).

FRANCE: Jura Sept., Montagne du Lomont, *L. Quélet* (Upsala); Seine, Bois de Boulogne, *Tulasne*, Mar. 16, 1846, type, Apr. 17, 1846 (Paris).

ENGLAND: KENT: Darenth Wood, *C. E. Broome*, Nov., 1869 (Brit. Mus.); *C. E. Broome*, Oct. 29, 1845 (Brit. Mus.); GLOUCESTERSHIRE: Tan Pits near Bristol, Oct. 14, 1847, *C. E. Broome* (Berk. Herb., Broome Herb., and two collections in Brown Univ. sub *H. tener*, one N. Y. Bot. Gard. sub *H. muticus*); Bentham Wood Hill, Oct. 6–10, 1859 (Currey Herb. at Brit. Mus.); Leigh Wood near Bristol, *C. E. Broome*, Oct. 30, 1879 (Brit. Mus.); Kingsweston near Bristol, Sept. 11, 1845 (Brit. Mus.); Stapleton Grove near Bristol, *C. E. Broome* (Brit. Mus.); WILTSHIRE: Hartham Park, Rudloe, *C. E. Broome*, distributed in Berkeley, Brit. Fungi, 305 *pro parte majore* (type distribution of *H. tener*, originally sub *H. lilacinus*, most of the material being *H. vulgaris*, but one specimen seen was true *H. tener*); Corsham House, *C. E. Broome*, Nov. 9, 1843; Lucknam, *C. E. Broome*, Sept. 20, 1859; SOMERSET: Batheaston, *C. E. Broome*, Nov., 1859 (all Brit. Mus.).

NEW YORK: near Ithaca, *H. M. Fitzpatrick 1119* (Cornell and Zeller).

OREGON: Linn County, Foster, *S. M. Zeller 8185* (Zeller).

ARGENTINA: Boca Riachuelo, *C. Spegazzini*, type of *H. australis* (N. Y. Bot. Gard.).

36. Hymenogaster gilvus Hesse, Hypog. Deutschl. **1**: 117. 1891; Sacc. Syll. Fung. **11**: 170–171. 1895.

Type: location unknown to us.

Fructifications scarcely the size of a hazelnut, irregular, often with a deep furrow at the base, whitish to faded yellow; peridium scarcely a line thick, fibrous without and within, with a middle layer of small-celled pseudoparenchyma; gleba greenish-yellow, cavities narrow and not very long but still visible without a lens; septa yellowish; basidia brownish, 2-spored, projecting beyond the septate paraphyses; spores 18–21 × 10–12 μ, similar to *H. Hessei* but narrower and longer; appendiculus 2–2.5 μ long, apiculate, exospore wrinkled and dark brown.

Under *Quercus* and *Fagus*. Hessen-Nassau, Germany. August to October.

37. Hymenogaster populetorum Tulasne, Ann. Sci. Nat. Bot. II. **19**: 375. 1843; Fung. Hypog. 66. 1851; DeToni in Sacc. Syll. Fung. **7**: 173. 1888; Hesse, Hypog. Deutschl. **1**: 119. 1891; Hollós, Magyar. Földalatti Gombai, 93–94, 205. 1911.—*not* Berkeley, Brit. Fung. 304.

*Splanchnomyces populetorum* Corda, Icones Fung. **6**: 42. 1854.

Illustrations: Tulasne, Fung. Hypog. *pl. 10, f. 10;* Corda, Icones Fung. **6**: *pl. 8, f. 83;* Hesse, Hypog. Deutschl. **1**: *pl. 5, f. 12.*

Type: in Berkeley Herb., fragment of type in Lloyd Mus.

Fructifications irregular, the size of a small walnut or filbert, smooth to innate-fibrillose, white, becoming dirty yellow and finally dark brown; sterile base scarcely visible; peridium thin, 75–100 μ, not separable but frequently eaten off, loosely stupose, hyaline with very thin darker rind; gleba brown, sometimes becoming almost black, fragile; septa 30–40 μ thick, composed of slender, hyaline, compact hyphae; basidia 2-spored, quickly gelifying; spores 18.5–26 × 10–18.5 μ, usually obtuse at the apex, ellipsoid, obovoid or ovoid, slightly appendiculate, utricle slightly roughened at maturity, brown.

In beech forest. France. Summer and autumn.

France: Doubs, Hérimoncourt, *L. Quélet*, June, July, 1880 (Upsala); Vienne, Loudun, Sablières de Condé, *Tulasne*, Oct., 1841, type (Kew and Paris).

38. HYMENOGASTER RENIFORMIS Hesse, Hypog. Deutschl. **1**: 119. 1891; Sacc. Syll. Fung. **11**: 171. 1895.

Type: location unknown to us.

Fructifications the size of a pea or smaller, reniform, amber-yellow, smooth above; peridium scarcely a line thick, composed of very slender, gelified hyphae; gleba somewhat fleshy and yellowish, cavities small but visible to the naked eye; septa yellow, composed of thin-walled, slender hyphae; basidia narrow, 2-spored, not projecting much beyond the paraphyses; spores 16–20 × 8–10 $\mu$, with a short, blunt apiculus, appendiculus 1 × 1 $\mu$, exospore wrinkled, dark yellow.

In sandy soil under *Fagus*. Hessen-Nassau, Germany. August to October.

The spores are near those of *H. lilacinus* Tul. but are narrower, and the appendiculus is thinner.

39. HYMENOGASTER **occidentalis** Zeller & Dodge, sp. nov.

Fructificationes laeves, 1–2 cm. diametro metientes, subsphericae, rugosae vel sulcatae, "pale tan" rubro-maculatae recens, "pinkish buff" vel "clay color" siccatae; peridium byssoideum, stuposum, fibrillosum, hyalinum, 50–100 $\mu$ crassitudine; gleba grisea, "snuff-brown" siccata, locellis magnis; septa fragilia, tenuia, 15–19 $\mu$ (ad 74 $\mu$ hymeniis inclusis) crassitudine, prosenchymatica, sublutea siccata; basidia cylindrica, angusta, 30–34 × 4–5 $\mu$, 2- vel 4-spora; sporae ellipsoideae, sublatae, apiculatae vel rotundatae in aliquantulis sporis maturis, pedicello brevi, utriculo laevi, episporio verrucoso, 20–26 × 12–15 $\mu$; odor terreus.

Type: in Zeller and Dodge Herbaria.

Fructifications smooth to silky, 1–2 cm. in diameter, sulcate-rugose to subglobose, pale tan, flecked with small patches of pink or red, drying pinkish-buff to clay-colored; peridium of a byssoid, stupose, or meshy fibrillose texture, hyaline, 50–100 $\mu$ thick; gleba grayish, drying snuff-brown, cavities relatively large; septa brittle, thin, papery, 15–19 $\mu$ thick (74 $\mu$ including hymenia), prosenchymatous, hyaline to yellowish when dry; basidia cylindrical, narrow, 30–34 × 4–5 $\mu$, 2- or 4-spored; spores mostly ellipsoid, slightly broad-apiculate, sometimes maturing with a broad rounded tip, pedicel notched, short, surface warted (warts mostly retrorse) and covered by a smooth utricle, 20–26 × 12–15 $\mu$. Odor earthy.

Scattered through loose moist soil under *Quercus* or *Abies*. Oregon and California. March to May.

Type: in Dodge and Zeller Herbaria.

OREGON: Benton County, Corvallis, *S. M. Zeller 6814*, type (Dodge and Zeller); Linn County, Foster, *S. M. Zeller 8186* (Zeller).

CALIFORNIA: Santa Clara County, Guadaloupe Mines, *H. E. Parks 431* (Dodge); Humboldt County, Trinidad, *H. E. Parks 4127* (Zeller).

40. HYMENOGASTER THWAITESII Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **18**: 75. 1846; Tulasne, Fung. Hypog. 71. 1851; Berkeley, Outlines Brit. Fungol. 297. 1860; DeToni in Sacc. Syll. Fung. **7**: 174–175. 1888; Massee, Ann. Bot. **4**: 47–48. 1889 [often cited as Monogr. Brit. Gast. 47–48. 1889]; Hesse, Hypog. Deutschl. **1**: 125–126. 1891.

Illustrations: Berkeley, Rept. & Trans. Birmingham Nat. Hist. Soc. **1881**: *pl. 3, f. 14;* Massee, Ann. Bot. **4**: *pl. 1, f. 25* [Monogr. Brit. Gast. *pl. 1, f. 25*]; Tulasne, Fung. Hypog. *pl. 10, f. 11.*

Type: in Berkeley Herb. at Kew.

Fructifications small, about the size of a pea, firm, dirty white, stained brown; peridium thin, 110–120 μ thick, smooth, composed of hyaline, very slender hyphae; gleba whitish, becoming brown, cavities elongated; septa thin and white; basidia slender, cylindrical, 2-spored; paraphyses broad, septate, hyaline; spores dark reddish-brown, rarely with a very small, blunt apiculus, obovoid or nearly spherical, 22 × 14 μ, rather rough or undulating-verrucose, often slightly appendiculate.

Rare under *Quercus* and *Fagus*. England. September to November.

ENGLAND: Portbury, *G. H. K. Thwaites*, Sept. 6, 1845, type (Berk. Herb., not Hooker Herb., at Kew); Kent, Tunbridge Wells, Oct., 1859 (sub *H. Klotzschii* at Kew).

41. HYMENOGASTER ALBELLUS Massee & Rodway, Kew Bull. Misc. Inf. **1898**: 126. 1898; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 253–254. 1902; Rodway, Papers & Proc. Roy. Soc. Tasmania **1911**: 28. 1912; **1923**: 152. 1924.

*Hymenogaster luteus* Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**: 247. 1899—*not* Vittadini, Monogr. Tuberac. 22. 1831.

Type: in Kew Herb.

Fructifications subspherical, 2–3 cm. in diameter, white, turning yellowish to light buff, drying yellow-ochre or ochraceous-buff, surface innate-fibrous, drying rugose; peridium thin, 18–30 μ thick, hyaline, the outer part composed of loosely applied, yellowish hyphae, the inner portion of more compact, stupose hyphae; gleba becoming fragile, Sudan brown to Argus brown, cavities irregular; septa thin, fragile, 12–25 μ thick, composed of hyaline, thin-walled, parallel hyphae; basidia 2-spored, broad-cylindric, 11–13 × 15–18 μ, sterigmata short, about 2–3 μ long; spores ellipsoid-citriform, apiculate, roughened by an evenly applied, alveolate utricle which extends to the base of the apiculus, dark brown (the young spores smooth, ellipsoid), 9.6–11.1 × 14.5–17 μ, including utricle.

Common in the southern hemisphere, also in California and Oregon. Under *Quercus*. October, in Oregon.

The young spores, where no utricle is developed, are smooth, ellipsoid, with no apiculus but usually with a pedicel attached. In some apparently semi-mature spores the utricle is less closely applied above, having a flaring tendency.

California: *H. E. Parks 1063*, 1929; Humboldt Co., Eureka, *Joseph P. Tracy* (com. H. E. Parks 4621); Alameda County, Berkeley, *N. L. Gardner 61, 69, 90, 119, 120, 238; G. Hahn* (com. N. L. Gardner 460); Oakland, *H. W. Harkness 12* (all sub *H. luteus*, Stanford); San Francisco, Parnassus Heights, *R. H. Kelley* (com. N. L. Gardner 23); *W. A. Setchell & C. C. Dobie* (com. N. L. Gardner 24); Santa Clara County, Alma, *H. E. Parks 1030* (all, except *Harkness 12*, Univ. Cal. and Zeller).

Oregon: Benton County, Corvallis, *S. M. Zeller 2563, 2565* (Zeller); *H. M. Gilkey* (Oregon State 5590, Zeller 8130); Linn County, *S. M. Zeller 2587;* Foster, *S. M. Zeller 7954* (both Zeller).

Brazil: *F. Rick 327* (Lloyd Mus.).

Uruguay: Montevideo, Sayago, 30 m., *G. Herter 3340, 3348a* (Berlin).

Chile: Magellanes, Punta Arenas, *R. Thaxter, Hymenogast. 1* (Farlow).

Tasmania: *L. Rodway 117*, type (Kew), *585, 1285* (Dodge); Cascades, *L. Rodway*, July, 1920 (Dodge).

New Zealand: Wellington, Palmerston North, *G. H. Cunningham 1141* (Dodge).

South Africa: Stellenbosch, *A. V. Duthie 209* (Lloyd Mus.).

42. Hymenogaster javanicus Hoehnel, Sitzb. K. Akad. Wiss. Wien **117**$^1$: 1017. 1908; Sacc. & Trotter in Sacc. Syll. Fung. **21**: 495. 1912.

Illustrations: Hoehnel, Sitzb. K. Akad. Wiss. Wien **117**$^1$: 1018.

Type: location unknown to us, probably non-existent.

Fructifications spherical or depressed, 0.7 × 0.9 cm., ochraceous; sterile base 2.5 × 1.5 mm. thick; peridium not separable, 350–400 μ thick, duplex, the outer layer loosely woven, of thick-walled, yellow-brown, septate hyphae, 5–11 μ in diameter, with swollen tips, the inner layer about 80 μ thick, pseudoparenchymatous, composed of thin-walled, hyaline cells 16 μ in diameter; gleba chocolate-color, cavities radially arranged from the base, up to 1.2 mm. long, about 0.4 mm. in diameter; septa about 120 μ thick, composed of thin-walled hyphae 4–6 μ in diameter, with pseudoparenchymatous subhymenial layer; basidia 26–28 × 10–14 μ, cylindrical, sterigmata 20 × 4 μ; spores brown, almost citriform, with a short hyaline apiculus, 17–18 × 10–12 μ, epispore fine-warted, covered by a smooth utricle.

In the forest at Tjibodas, Java.

This species is very close to *H. albellus,* from which it differs in its much larger dimensions. However, the fact that this description may have been drawn up from fresh specimens or from those preserved in alcohol, while we have seen largely dry material in *H. albellus,* may be sufficient to account for the discrepancy. The specimen, "Magellanes, Chile, *R. Thaxter,*" which has been preserved in alcohol and which we unhesitatingly referred to *H. albellus* shows measurements very closely approximating Hoehnel's measurements of *H. javanicus.*

43. HYMENOGASTER SULCATUS Hesse, Hypog. Deutschl. **1**: 111. 1891; Sacc. Syll. Fung. **11**: 170. 1895; Soehner, Zeitschr. f. Pilzk. **2**: 157. 1923.

Illustrations: Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 27.*

Type: in Bot. Inst. Univ. Marburg.

Fructifications under 1 cm. in diameter, very irregular, at first yellow, then dark red-brown, becoming blue-gray in alcohol, with a characteristic deep groove at the base, along which the portions of the fructification easily separate and grooves also traverse the surface; peridium 80–100 μ thick (dry), the outer part composed of loosely woven hyphae, the middle part of compact prosenchyma; gleba brownish-yellow, cavities small, nearly filled with spores; septa 25–37 μ thick, composed of loosely woven hyphae; basidia long and slender, 2-, rarely 3-,spored, much longer than the paraphyses, brown; paraphyses broad; spores 24–36 × 10–16 μ, with a short, blunt apiculus, long-appendiculate, exospore very thin, covered with small flakes.

In the humus layer under *Quercus* and *Fagus*, along with *Hysterangium calcareum*. Central Europe and Oregon. April to October.

U. S. S. R. [RUSSIA]: Moskva, Mikhailovskoe, and road to Sekirino, *F. Bucholtz*, Aug. 25, 1907 (sub *H. vulgaris a* and *H. tener a*, Farlow); Ukraine [near Kharkov], *B. M. Czernaiev* (sub *H. vulgaris*, det. Berkeley, Upsala).

GERMANY: Kirchditmold, *R. Hesse*, V, 1889, type, and IV, 1890; Stadtwald, *R. Hesse*, VIII, 1890 (both Hesse); Bad Vorisshofen, *E. Soehner 488* (Soehner).

WALES: Nant y Glyn, *C. E. Broome*, Oct., 1880 (Brit. Mus.).

OREGON: Benton County, Corvallis, *S. M. Zeller 2425* (Zeller).

44. HYMENOGASTER HESSEI Soehner, Zeitschr. f. Pilzk. **2**: 158. 1923.

*Hymenogaster vulgaris* Hesse, Hypog. Deutschl. **1**: 114–115. 1891—*not H. vulgaris* Tulasne.

Illustrations: Hesse, Hypog. Deutschl. 1: *pl. 2, f. 14–15; pl. 7, f. 30.*

Type: in Bot. Inst. Univ. Marburg.

Fructifications the size of a hazel-nut, irregular, base remaining sterile for a long time, white to dirty gray; peridium shining, papery, drying 18–26 μ thick, not separable, composed of pseudoparenchyma in the middle and a fibrous layer next the gleba; gleba white, becoming brown to blackish, cavities irregular; septa 18–20 μ thick, composed of loosely woven hyphae; basidia of medium size, cylindric, surpassing the paraphyses in length, 2-spored; spores broad obovoid-citriform with a very roughly wrinkled utricle, golden-yellow when young, then darker, 16–22 × 10–15 μ, appendiculus 1.5 μ long and 2.5 μ broad, like a pair of claws, apiculus short, blunt.

Under *Quercus* and *Fagus*. Hessen-Nassau, Germany. August to October.

The young spores of *H. verrucosa* Bucholtz are of the same magnitude and shape as mature spores of *H. Hessei*, and might be mistaken for the latter. However, the spores of *H. verru-*

*cosa* are provided with a finely verrucose epispore covered with a rather closely applied utricle, so that the young spores appear finely beaded, while in *H. Hessei* the utricle is dark and roughly wrinkled.

GERMANY: Hessen-Nassau, Marburg, Caldernesstrasse, *R. Hesse,* Oct. 6, 1886, type (Hesse).

45. HYMENOGASTER **fusisporus** (Massee & Rodway) Zeller & Dodge, comb. nov.

*Hysterangium fusisporum* Massee & Rodway, Kew Bull. Misc. Inf. **1898**: 127. 1898; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 247. 1902; Rodway, Papers & Proc. Roy. Soc. Tasmania **1911**: 26. 1912; **1923**: 155. 1924.

*Hymenogaster Barnardi* Rodway, Papers & Proc. Roy. Soc. Tasmania **1920**: 157. 1921; *fide* Rodway, *Ibid.* **1923**: 161. 1924.

Type: in Kew Herb.

Fructifications 0.5–2 cm. in diameter, subglobose to irregular, surface cottony to innate-stupose, white to straw-color, drying cream-buff; peridium thin, 25–80 μ thick, continuous with the septa and not easily separable, hyaline, cottony-stupose; slight sterile base; gleba rather dense, with small sinuous cavities, pallid, drying maize-yellow to apricot-yellow; septa thin, 8–15 μ thick, fragile, hyaline, stupose; basidia 2-spored, sterigmata short; spores hyaline or dilute yellowish, fusiform, acute at both ends, 20–22 × 8–9 μ, smooth, with slight apiculus, epispore inconspicuous.

Hypogeous. Tasmania.

TASMANIA: *L. Rodway 276* type (Kew), *1113, 1271* (as *H. Barnardi* Rodway, Dodge and Zeller); Hobart, *L. Rodway* (Lloyd Mus. 084); Cascades, *L. Rodway 1119* (Lloyd Mus.).

46. HYMENOGASTER TOMENTELLUS Hesse, Hypog. Deutschl. **1**: 112. 1891; Sacc. Syll. Fung. **11**: 170. 1891.

Type: location unknown to us.

Fructifications the size of a hazel-nut, irregular, yellowish-white when young, becoming brownish, finally golden-yellow and somewhat shining; peridium very thin, fibrous, composed of very slender hyphae, not separable; gleba red-brown, cavities small; septa thin and whitish-yellow, composed of septate, branched, somewhat gelified hyphae; basidia narrow-cylindric, 2-spored, extending slightly above the paraphyses, brownish; spores citriform, with long, blunt, hyaline apiculus, and wrinkled exospore, golden-yellow to dark red-brown, usually appendiculate, 27–29 × 11–13 μ.

In calcareous earth under *Fagus* and *Quercus*. Hessen-Nassau, Germany. August to October.

47. HYMENOGASTER **Parksii** Zeller & Dodge, sp. nov.

Fructificationes spongiosae, laeves, subsphericae, 0.5–1.5 cm. diametro metientes, sordide albidae vel griseae, "cinnamon buff" vel "clay color" siccatae; peridium 35–75 μ crassitudine, byssoideum, stuposum, facile laceratum; gleba grisea, "Natal brown" siccata; septa 18–25 μ crassitudine, stuposum, compactum; basidia 4-spora, cylindrica; sporae maturae nigerrimae, verrucosae, obovoideae vel late ellipsoideo-citriformes, 18.5–26 × 12.2–17 μ, sporae immaturae laeves, flavae ut in *H. citrino* aut in *H. Bulliardi*, 22–24 × 11–14 μ, apiculatae pedicellataeque.

Type: in Univ. Cal., Dodge, and Zeller Herbaria.

Fructifications soft, spongy, smooth, subspherical, 0.5–1.5 cm. in diameter, dirty white to gray, becoming cinnamon-buff to clay-color on drying; peridium 35–75 μ thick, cottony-stupose, hyaline, easily torn; gleba grayish, drying Natal brown, cavities first developing above; septa 18–25 μ thick, coarse-stupose, compact; basidia 4-spored, cylindrical; spores very dark, verrucose at maturity, obovoid- or broadly ellipsoid-citriform, young spores smooth, clear yellowish, and resembling *H. citrinus* when narrow or *H. Bulliardi* when broad, mature spores 18.5–26 × 12.2–17 μ, young spores 22–24 × 11–14 μ, apiculate and pedicellate.

Scattered just under leaves and through the soil about 5 cm. deep under *Quercus* and *Heteromeles arbutifolia*. California. November to April.

CALIFORNIA: Santa Clara County, Guadaloupe Mines, *H. E. Parks 432, 950* type (Univ. Cal., Dodge and Zeller); San Mateo County, Lower Los Trancos Creek, Palo Alto, *James McMurphy 276*, Jasper Ridge, Palo Alto, *J. McMurphy 300* (Stanford and Zeller).

48. HYMENOGASTER ARENARIUS Tulasne, Giorn. Bot. Ital. **1**$^2$: 55. 1844; Fung. Hypog. 73. 1851; DeToni in Sacc. Syll. Fung. **7**: 168. 1888; Soehner, Hedwigia **64**: 192–202. 1923.

*Hymenogaster pusillus* Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **18**: 75. 1846; Tulasne, Fung. Hypog. 73. 1851; Cooke, Handbook Brit. Fung. **1**: 363. 1871; De Toni in Sacc. Syll. Fung. **7**: 173. 1888; Massee, Ann. Bot. **4**: 48–49. 1889 [often cited as Monogr. Brit. Gast. 48–49. 1889]; Hesse, Hypog. Deutschl. **1**: 125. 1891; Hollós, Magyar. Földalatti Gombai, 94–95, 206. 1911; Soehner, Hedwigia **64**: 192–202. 1923.

*Hymenogaster Suzukianus* Hennings, Bot. Jahrb. [Engler] **32**: 41. 1902; Sacc. & D. Sacc. in Sacc. Syll. Fung. **17**: 240. 1905.

Illustrations: Soehner, Hedwigia **64**: 196; Tulasne, Fung. Hypog. *pl. 10, f. 2;* Massee, Ann. Bot. **4**: *pl. 1, f. 21.*

Type: France, Seine, Bois de Boulogne, *Tulasne.* Original collection not found but material from the same locality collected a little later is abundant in Paris and agrees closely with the description and figures. Type of *H. pusillus,* "England, Rushton, Berkeley, Oct. 8, 1845," at Kew, mostly eaten by insects. Judging from the size of the glue spots, about 2 mm. in diameter, one specimen shows trace of a sterile base and one of the peridium, while one slice seems intact. Type of *H. Suzukianus,* "Japan, Komaba, *F. Suzuki 45,* April, 1900," is in Botanisches Museum at Berlin-Dahlem.

Fructifications spherical to obovate, about 1 cm. in diameter, white, unchanging, smoke-gray in alcohol, drying Brussels brown; sterile base slight; peridium 200–320 μ thick when fresh, composed of large, thin-walled, hyaline hyphae 7–8 μ in diameter, drying to about 35–40 μ thick (in the type); gleba white, becoming smoke-gray, cavities more or less spherical, radiating from the base; septa 70–100 μ thick, with trama proper about 22–35 μ thick, of large thin-walled compact prosenchyma, the cells of which are 3–5 μ in diameter, with a pseudoparenchymatous subhymenium; basidia 30–35 × 5–7 μ, cylindrical, sterigmata long; spores ovoid- to ellipsoid-citriform, coarsely verrucose (6–8 warts to a spore length), apiculate, pedicellate, 11–18 × 8.5–11 μ, rufous-brown.

In sandy or gravelly soil in woods. Cosmopolitan in the northern hemisphere. September to November.

The type of *H. pusillus* is very young material which may account for the small size of the fructifications. For this reason the septa are very broad and the peridium is thick, but new cavities are being formed in the fundamental tissue of its inner portion which doubtless should be considered as glebal tissue.

U. S. S. R. [RUSSIA]: Moskva, Mikhailovskoe, *N. Mossolov*, Aug. 5, 1906 (sub. *H. verrucosa β*, Bucholtz Herb. at Farlow).

FINLAND: Mustiala, *P. A. Karsten* (2 coll.).

GERMANY: Bayern, München, Englische Garten, *E. Soehner 205*, May 20, 1923 (Soehner); Hessen, Caldernesstrasse near Marburg, *R. Hesse*, 1901, Saxe Weimar, Eisenach, *R. Hesse*, 1899 (both Hesse).

FRANCE: Seine, Bois de Boulogne, *Tulasne*, 1845 (Paris); Jura?, *L. Quélet* (sub *H. pusillus*, Upsala).

ENGLAND: Portbury, *G. H. K. Thwaites*, 1845 (Hooker Herb. at Kew); Rushton, *M. J. Berkeley* (type of *H. pusillus*, Kew); Bristol, *C. E. Broome* (sub *H. decorus*, N. Y. Bot. Gard.).

MAINE: York County, Kittery Point, Cutts Island, *R. Thaxter*, Aug. 9, 1921, Sept. 10, 1903, Sept. 15, 1902, Apr. 18, 1903 (immature) (all Farlow).

JAPAN: Komaba, *F. Suzuki 45* (Berlin).

NEW YORK: Onondaga County, Jamesville, *A. H. Povah 909* (Farlow).

CALIFORNIA: Alameda County, San Francisco, *N. L. Gardner 88* (Univ. Cal. and Zeller); Santa Cruz County, Felton, *H. E. Parks 502, 512* (Univ. Cal. and Zeller).

49. HYMENOGASTER ZEYLANICUS Petch, Ann. Roy. Bot. Gard. Peradeniya **6**: 207–208. 1917; Trotter in Sacc. Syll. Fung. **23**: 599–600. 1925.

Type: in Herb. Roy. Bot. Gard. Peradeniya, a portion in Dodge Herb. and Zeller Herb.

Fructifications subglobose or depressed, up to 2 cm. in diameter, drying to 1.2 cm., brownish-yellow, drying pinkish-cinnamon or darker, sterile base absent; peridium thin, 25–40 μ thick when dry, composed of loosely woven, large, thin-walled hyphae 3–4 μ in diameter; gleba Argus brown when dry, cavities small, irregularly polygonal in the center, tending to rectangular and elongate toward the periphery, empty; septa 10–15 μ thick, compact, composed of highly gelified hyphae; basidia not seen; spores yellow-brown, ovoid-citriform, sometimes with a very slight apiculus, sometimes pedicellate, mostly acutely rounded above, exospore very slightly verrucose and covered with a closely applied utricle which appears somewhat beaded or alveolate, especially below, utricle sloughing above and below, causing considerable roughening below, 13–15 × 8–10 μ.

Hypogeous. Ceylon. March to May.

CEYLON: Peradeniya, *O. Beccari*, May 10, 1885 (Brit. Mus.); Hakgala, *T. Petch 4603* type, *5478, 5479, 6437* (Peradeniya and Kew).

50. HYMENOGASTER CEREUS Hesse, Hypog. Deutschl. **1**: 128. 1891; Sacc. Syll. Fung. **11**: 171. 1895.

Illustrations: Hesse, Hypog. Deutschl. **1**: *pl. 7, f. 39.*

Type: location unknown to us.

Fructifications the size of a pea or bean, spherical, occasionally subovoid, white, becoming dull yellow; peridium unusually thin, dry, without fibrils, yellowish, composed of richly septate hyphae; gleba wax-like or fleshy, white, dull, cavities long, easily visible; basidia short, slender, 2-spored, not projecting beyond the septate paraphyses; spores broad-ellipsoid, rounded at the apex, without papilla, with a short, broad appendiculus, 16–19 × 6–10 μ, yellowish-brown, exospore wrinkled.

Under the leaf cover in forest of *Quercus* and *Fagus*. Hessen-Nassau, Germany. August and September.

51. HYMENOGASTER LUTEUS Vittadini, Monogr. Tuberac. 22. 1831; Tulasne, Fung. Hypog. 65. 1851; Quélet, Mém. Soc. d'Émulation de Montbéliard —: 377. 1873 [often cited as Champ. du Jura et des Vosges **2**: 369. 1873]; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 875. 1883; DeToni in Sacc. Syll. Fung. **7**: 171. 1888; Massee, Ann. Bot. **4**: 43. 1889 [often cited as Monogr. Brit. Gast. 43. 1889]; Hesse, Hypog. Deutschl. **1**: 130–131. 1891; Soehner, Zeitschr. f. Pilzk. **2**: 157. 1923.

*Splanchnomyces luteus* Corda, Icones Fung. **6**: 40. 1854.

*Splanchnomyces Berkeleyanus* Corda, Icones Fung. **6**: 43. 1854.

Illustrations: Vittadini, Monogr. Tuberac. *pl. 3, f. 9;* Tulasne, Ann. Sci. Nat. Bot. II. **19**: *pl. 17, f. 11–13;* Fung. Hypog. *pl. 1, f. 3;* Corda, Icones Fung. **6**: *pl. 8, f. 76, 85;* Massee, Ann. Bot. **4**: *pl. 1, f. 18;* Quélet, Mém. Soc. d'Émulation de

Montbéliard [often cited as Champ. du Jura et des Vosges **2:** *pl. 4, f. 1*].

Type: location unknown to us, although material so determined by Vittadini in Kew, Paris, and Upsala.

Fructifications depressed-globose, 1–2 cm. in diameter, drying 1.0–1.2 cm., snow-white, becoming yellow, drying bay, soft, cottony, fibrils not evident, sterile base narrowly conical; peridium 40–45 μ thick, composed of slender, thick-walled, hyaline hyphae with many white, diamond-shaped crystal inclusions; gleba yellow, drying Sudan brown, cavities small, filled with spores; septa thin, 11–18 μ thick, composed of very slender, closely interwoven hyphae, with crystal inclusions, scissile at the angles; basidia not seen; spores smooth, ovoid-fusiform, tapering to a short point, often not symmetrical, 18–22 (–28) × 9–11 μ.

Hypogeous in forest duff. Europe. September to January.

U. S. S. R. [Russia: Ukraine], near Kharkov, *B. M. Czernaiev* (as *H. Klotzschii*, det. Berkeley, Upsala).

Germany: Bayern, Planegg bei München, *E. Soehner 688* (Soehner).

Italy: Lombardia, Milano, *C. Vittadini* (Kew, Paris, and Upsala); *Mattirolo 9* (Lloyd Mus.).

France: Vaucluse, *L. Quélet* (Upsala).

England: Norfolk, King's Lynn, *C. B. Plowright* (Berlin); Wiltshire, *C. E. Broome* (Brown Univ.).

51a. var. subfuscus Soehner, Krypt. Forsch. **1:** 394–395. 1924.

This variety differs in that the surface of the fructification is never pure white, but dirty white with gray tones; gleba not sulphur-yellow but gray-white tending toward brownish and becoming Vandyke brown in age.

Martinsried, Planegg, Germany. Rare.

52. Hymenogaster levisporus Massee & Rodway in Rodway, Papers & Proc. Roy. Soc. Tasmania **1911:** 30. 1912.

Type: in Kew.

Fructifications irregularly spherical, 1.5–2.5 cm. in diameter, white; peridium very thin, 45–75 μ thick, subfloccose, stupose, continuous with the surrounding mycelium; large hemispherical base drying warm buff, with radius of 3 mm. becoming obsolete; gleba rather dense, pale brown, drying Argus brown, cavities small; septa hyaline, 37–45 μ thick, of interwoven hyphae; spores pale brown, obovoid-ellipsoid to subspherical, smooth but very slightly roughened on the distal end, slightly pedicellate, 8–9 × 5.5–6 μ.

South Australia and Tasmania. May.

SOUTH AUSTRALIA: Encounter Bay, *J. B. Cleland 20* (Dodge and Zeller).
TASMANIA: *L. Rodway 653*, type (Kew).

53. HYMENOGASTER **Remyi** Zeller & Dodge, sp. nov.

Fructificationes subsphericae, reniformes, depressae, 2.5 × 1.5 cm. siccatae, albidae vel isabellinae, laeves vel innato-fibrillosae, basis sterilis non visa; peridium laxe stuposum, hyphis contextis, 60–75 μ crassitudine, hyalinum; gleba ''Argus brown'' vel ''Brussels brown,'' cavitatibus mediocribus; septa stuposa, 30–35 μ crassitudine, hyalina, gelificata; basidia clavata, tetraspora; sporae obovoideae vel ellipsoideae, inferne attenuatae, brunneae, minute verrucosae, 8–11 × 5.5–7.5 μ.

Type: in Patouillard Herb. at the Farlow Herbarium of Harvard University.

Fructifications subspherical, reniform or depressed, 2.5 × 1.5 cm. when dry, whitish or isabelline when dry, no sterile base; peridium loosely stupose, of interwoven hyphae, 60–75 μ thick, hyaline; gleba Argus brown to Brussels brown, with medium cavities; septa stupose, 30–35 μ thick, hyaline, somewhat gelified; basidia clavate, 4-spored; spores obovoid or ellipsoid, attenuated below, brown, minutely verrucose with distal end quite warted, 8–11 × 5.5–7.5 μ.

The young spores have an extremely attenuated base. This species differs from the other species of the *H. albus* group in the attenuated obovoid spores.

FRANCE: Hautes Alpes, Briançon, *M. Remy*, type (Farlow).

54. HYMENOGASTER MAIDENI Rodway, Papers & Proc. Roy. Soc. Tasmania **1920**: 157. 1921; **1923**: 152. 1924; Trotter in Sacc. Syll. Fung. **24**: 1327–1328. 1928.

Type: in Rodway Herb. but not seen by us.

Fructifications globose, 2 cm. in diameter; peridium very thin, white or slightly ochraceous when exposed; sterile base obsolete; gleba white, becoming pale ochre when dry, tough, canals numerous, small, contorted; spores ovoid to oblong, yellow-brown, smooth, 10–12 × 6 μ, one or both ends subacute.

McRobie's Gully, Tasmania.

Rare. Differing from *H. albellus* in paler gleba and spores. —Rodway.

## DOUBTFUL SPECIES

1. HYMENOGASTER AROMATICUS Velenovsky, Česky Houby, 800. 1922.

Fructifications the size of a walnut, rounded, but with rhizomorphous stipe at base with coarse grooves without any fibrils, at first pure white, smooth, then dirty yellowish, quite strong, hard, and only somewhat peeling; gleba elastic, like a mushroom, composed of quite large, yellowish-brown chambers with light walls; spores copper-yellow, ovoid-ellipsoid, with truncate narrowed base, rough, 12–14 μ long, apex 2 μ long.

In dark humus in woods of young pine, deep under the surface, on warm southern slopes at Jilovist, first of May, 1915. This species has a very agreeable, strong odor of fruit. It is related to *H. muticus, H. luteus,* etc., but is distinguished by its small spores.

2. HYMENOGASTER AUREUS Rodway, Papers & Proc. Roy. Soc. Tasmania **1923**: 152–153. 1924.

Type: in Rodway Herb. but not seen by us.

Irregularly subglobose, mostly 1–2 cm. in diameter, bright golden-yellow, surface rugose; peridium tough, yellow, about 0.5 mm. thick; gleba compact, pale brown, canals small, numerous, contorted; spores ellipsoid-fusiform, quite smooth, allantoid, pale yellow, 15–21 × 6 μ.

Mt. Wellington, 3,000 feet.

Differs from *H. albellus* in color, thickness of peridium, and glabrous allantoid spores.

3. HYMENOGASTER FLAVIDUS Bonorden, Hedwigia **15**: 49–50. 1876: DeToni in Sacc. Syll. Fung. **7**: 491. 1888.

Type: location unknown to us.

Fructifications various, mostly globose, bright yellow when young with rose-colored and white spots on the base (at least when exposed to the air), becoming dark yellow on ripening; peridium thin, papery, composed of branching, anastomosing, septate hyphae; gleba white, horn-like, cavities irregular; septa composed of short, articulated, inflated hyphae [pseudoparenchyma?]; basidia ovoid; spores sessile, oblong, hyaline.

Schwetzinger forest, near Heidelberg, Germany.

There is little in the above description to suggest *Hymenogaster,* but we prefer to wait until further study before transferring it (cf. *Hysterangium Petri* or *H. Rickeni* var. *pinetorum*).

4. Hymenogaster rufus Vittadini, Monogr. Tuberac. 23. 1831; Tulasne, Fung. Hypog. 64. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 874. 1883; DeToni in Sacc. Syll. Fung. **7**: 174. 1888.

Illustrations: Vittadini, Monogr. Tuberac. *pl. 3, f. 17.*

Fructifications subglobose, the size of a filbert; peridium whitish, rufescent, sub-silky, thin, subtomentose, with a minute sterile base; gleba reddish, fuscous, cavities a little larger and irregular; septa whitish, homogeneous; spores obovoid, subsessile, rufous; odor weak.

With *Hymenogaster Bulliardi.* Transpadane Province, Italy. Winter.

Similar in appearance to a fructification of *Gautieria morchelliformis.* Easily mistaken for *Hymenogaster lycoperdineus,* from which it may be distinguished by the color of the gleba, odor and shape of the spores.

5. Hymenogaster Setchellii Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**: 246. 1899; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 254. 1902.

Type: location unknown to us, not among the cotypes in Dudley Herb. at Stanford Univ.

Minute, 1.5 cm. in diameter, white, turning to brown, subglobose, smooth; gleba buff, elastic; cells large, sinuous; sterigmata elongated; spores citriform, guttulate, 7 × 9 $\mu$.

Under *Vaccinium*, beneath vegetable humus. Mt. Tamalpais, Marin County, California. April.

### EXCLUDED SPECIES

1. HYMENOGASTER FULVUS Rodway, Papers & Proc. Roy. Soc. Tasmania **1917**: 109. 1918; **1919**: 112. 1920; Lloyd, Myc. Notes 65: 1088. 1921; Trotter in Sacc. Syll. Fung. **24**: 1327. 1928, is *Rhizopogon rubescens* Tulasne.

2. HYMENOGASTER MICROSPORUS Berkeley, Jour. Linn. Soc. [London] Bot. **9**: 423. 1867; DeToni in Sacc. Syll. Fung. **7**: 171. 1888, is **Lycoperdon microsporus** (Berkeley) Zeller & Dodge, comb. nov.

3. HYMENOGASTER PUMILIONUM Ade, Mitt. Bayer. Bot. Ges. **2**: 219. 1909; Sacc. & Trotter in Sacc. Syll. Fung. **21**: 496. 1912, is *Rhizopogon Pumilionum* Bataille, Bull. Soc. Myc. France **39**: 170. 1923, or *Rhizopogon rubescens* Soehner, Krypt. Forsch. **1**: 393. 1924. Soehner studied the type, which seemed to him to be an alpine form of the latter species.

4. HYSTERANGIUM **Moselei** (Berk. & Br.) Zeller & Dodge, comb. nov.

*Hymenangium Moselei* Berkeley & Broome, Jour. Linn. Soc. [London] Bot. **16**: 40. 1877.

*Hymenogaster Moselei* DeToni in Sacc. Syll. Fung. **7**: 172. 1888.

Type: in Broome Herb. at Brit. Mus. and in Berk. Herb. at Kew.

Fructifications about 1.2 cm. in diameter, subspherical, attenuate at the base, citrine-yellow, smooth, becoming wrinkled on drying; peridium variable in thickness, up to 320 μ thick, of loosely woven subparallel gelified hyphae 8–9 μ in diameter, columella inconspicuous, branching near the white base; gleba ochraceous, drying raw sienna to antique brown; septa 14–20 μ thick, of very slender parallel, gelified hyphae; basidia pyriform, 7–9 × 5–6 μ, sterigmata short; spores smooth, ellipsoid, light yellow, about 10–11 × 4–5 μ.

NEW SOUTH WALES: Pennant Hills near Parramatta, *Challenger Exp.*, type (Brit. Mus. and Kew).

### RICHONIELLA

*Richoniella* Costantin & Dufour, Fl. Champ. 203; Bataille, Bull. Soc. Myc. France **39**: 179. 1923.

*Nigropogon* Coker & Couch, Gasteromycetes Eastern U. S. & Canada, 37–38. 1928.

The type species is *Hymenogaster leptoniisporus* Richon. The type species of *Nigropogon* is *N. asterosporus* Coker & Couch.

Fructifications subglobose to irregular; fibrils lacking or merely rudimentary below; peridium prosenchymatous, entirely enclosing a gleba; gleba white, becoming colored like the spores, cavities sinuous, empty or nearly filled with spores; septa prosenchymatous, continuous with the peridium; basidia 2–4-spored; spores angular as in *Leptonia*, russet or rosy.

### KEY TO SPECIES OF RICHONIELLA

Spores 12–15 μ long, angles of spores acute-rounded....*R. asterospora* (p. 683).
Spores 8–11 μ long, angles of spores obtuse-rounded....*R. leptoniispora* (p. 684).

1. RICHONIELLA **asterospora** (Coker & Couch) Zeller & Dodge, comb. nov.

*Nigropogon asterosporus* Coker & Couch, Gasteromycetes Eastern U. S. & Canada 37–38. 1928.

Illustrations: Coker & Couch, Gasteromycetes Eastern U. S. & Canada, *pl. 108, f. 3–7.*

Type: in Univ. N. Car. Herb.

Fructifications hypogeous, 1 cm. thick, drying about ½ the diameter, subglobose, surface smooth, nearly pure white, drying tawny or Sanford's brown, attached by fibrils at the base; peridium 100–220 μ thick, drying 18–37 μ thick, of hyaline, homogeneous prosenchyma; gleba pure white, becoming pale vinaceous-russet or pecan-brown, drying Sayal brown, cavities sinuous, empty; septa 80–100 μ thick, drying 20–30 μ, of hyaline, compact prosenchyma, continuous with the peridium; basidia 7.5–9 μ thick below, 5.5–6.5 μ thick above, 26–38 μ long, 4-spored (rarely 2-), distal half collapsing after spore maturity;

spores nearly sessile, pale russet *en masse,* angular as in *Leptonia,* angles acute, usually 4-angled in optical section, attenuated below, 12–15 × 8–11.5 μ. "Odor when fresh slightly like an old Irish potato but not unpleasant; on drying becoming like that of ham, faintly nitrous or phosphorous."

Slightly buried in soil under deep layer of decayed leaves of *Quercus* and *Cornus.* North Carolina. October.

NORTH CAROLINA: Orange County, Chapel Hill, *J. N. & Else E. Couch,* type (Univ. N. Car. 8271).

2. **RICHONIELLA LEPTONIISPORA** (Richon) Costantin & Dufour, Fl. Champ. 203; Bataille, Bull. Soc. Myc. France **39**: 179. 1923.

*Hymenogaster leptoniisporus* Richon, Bull. Soc. Bot. France **34**: 59–60. 1887; Catal. Champ. Marne, 518. 1889; DeToni in Sacc. Syll. Fung. **7**: 172–173. 1888; Sacc. & Fautrey, Bull. Soc. Myc. France **16**: 25. 1900.

Illustrations: Richon, Bull. Soc. Bot. France **34**: *pl. 2, f. 1;* Catal. Champ. Marne, 518; Costantin & Dufour, Fl. Champ. *pl. 68, f. 25;* Sacc. & Fautrey, Bull. Soc. Myc. France **16**: *pl. 2, f. 1.*

Type: France, Marne, Luzernières, *C. Richon,* not seen by us.

Fructifications 5–6 cm. high, 1.5–4.5 cm. in diameter, fleshy but firm, spherical to pyriform or irregularly lobed, white at first, then ochraceous, smooth, depressed below and usually without fibrils but rarely with a fascicle of brown fibrils below; peridium 18–30 μ thick, of hyaline prosenchyma with a darker surface with soil inclusions; gleba white at first, then rufescent, cavities irregular; septa 20–30 μ thick, of hyaline prosenchyma; sterigmata short, basidia crowded, obovoid, 2–4-spored; spores angular as in *Leptonia,* angles obtuse-rounded, smooth, at first hyaline then pink or rosy, guttulate, 8–11 × 7–9 μ. Odor none.

Solitary or gregarious; hypogeous, in cultivated fields or grassy locations. France. August to October.

FRANCE: Meuse, Verdun, *M. Paneau* (Paris and Patouillard ex Herb. Boudier).

### DENDROGASTER

*Dendrogaster* Bucholtz, Hedwigia **40**: 316–318. 1901; Материалы къ морфологіи и систематикѣ подземныхъ грибовъ . . .

Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ с. Михайловскомъ Московской Губ. **1**: 148–151. 1902 [often cited as Beitr. Morph. Syst. Hypog.]; Sacc. & D. Sacc. in Sacc. Syll. Fung. **17**: 240–241. 1905.

The type species of the genus is *Dendrogaster connectens* Bucholtz.

Fructifications spherical to reniform; columella dendroid, sometimes prolonged into a short stipe-like rooting base; peridium varying from simple to duplex and from slender hyphae to pseudoparenchyma, always well developed; gleba usually some shade of brown; septa of slender hyphae; basidia mostly 4–2-spored; spores ellipsoid to fusiform, occasionally obovoid, sculptured as in *Hymenogaster,* but with a conspicuous utricle, or nearly smooth in other species.

This genus is intermediate between species of *Gautieria* with a well-developed peridium and *Hymenogaster.* It differs from *Gautieria* in the conspicuous utricle, and from *Hymenogaster* in the well-developed columella, the utricle being more conspicuous than in most species of *Hymenogaster* as well.

While the genus is widespread, the individuals are rather rare and the species are known only from a very limited area, several only from the type collection.

## KEY TO SPECIES OF DENDROGASTER

1. Spores covered by a loose, saccate utricle.............................. 3
1. Spores not covered by a loose, saccate utricle............................ 2
  2. Spores 14–18 × 9.5–12 $\mu$, obovoid-ellipsoid, brown.........*D. major* (p. 686)
  2. Spores 20–25 × 11–16.5 $\mu$, obovoid to subcitriform; peridium glabrous, thin ..........................................*D. megasporus* (p. 686)
  2. Spores 9–12 × 6–7 $\mu$, ovoid; peridium villose with tufts of erect hyphae.... ..........................................*D. cambodgensis* (p. 687)
  2. Spores 10–13.5 × 7–9 $\mu$, ellipsoid, minutely striate-verrucose; peridium flaking off, leaving patches......................... *D. candidus* (p. 688)
  2. Spores 12.5–15 × 8–10 $\mu$, ellipsoid, broadly truncate below, minutely verrucose on sides, coarsely so above, covered by a utricle, pinkish........ ..........................................*D. radiatus* (p. 688)
3. Spores large, smooth, 20 × 10.7 $\mu$.....................*D. connectens* (p. 689)
3. Spores about half as long as above.................................... 4
  4. Peridium 220 $\mu$ or more thick; septa 70–80 $\mu$ thick; spores smooth, with conspicuous utricle, 10–13.5 × 6–7.5 $\mu$...............*D. utriculatus* (p. 689)
  4. Peridium thinner, less than 175 $\mu$ thick; septa less than 60 $\mu$ thick....... 5

5. Peridium 80–140 μ thick; spores slightly verrucose, 8–11 × 5–6 μ.......... ...............................................*D. globosus* (p. 690)
5. Peridium 100–175 μ thick; spores smooth, 10.5–11 × 6–7 μ...*D. foetidus* (p. 691)

### 1. **Dendrogaster major** Zeller & Dodge, sp. nov.

Fructificationes oblate spheroideae, 2–3.5 cm. diametro, 1.5–2 cm. altitudine metientes, colore (recentium) ignota, superficie laevi, sericea; basis sterilis prominens, pulvinata (immatura); columella ramosa, crassa, percurrens, ramis tenuibus, planatis; peridium 240–300 μ crassitudine servatum, hyphis tenuissimis contextum; gleba brunnea, locellis ab columella radiantibus; septa 140–160 μ crassitudine, hyphis hyalinis tenuibus contexta; basidia 16–18 × 6–7 μ, hyalina, tetraspora; sporae obovoideo-ellipsoideae, brunneae, guttulatae, episporio verrucoso, 14–18 × 9.5–12 μ,

Type: in Dudley Herb. at Stanford, Zeller Herb., and Dodge Herb.

Fructifications oblate-spheroidal, 2–3.5 cm. in diameter, 1.5–2 cm. high, becoming muddy color in preservative, surface smooth, silky; sterile base prominent, pulvinate (in young specimens), leading upward into a stout branched, percurrent columella with thin, flattened branches; peridium 240–300 μ thick (in preservative), of very slender, hyaline, interwoven hyphae; gleba brown, cavities radiating from the columella and its branches; septa 140–160 μ thick, of very slender, hyaline, interwoven hyphae; basidia 16–18 × 6–7 μ, hyaline, 4-spored; spores obovoid-ellipsoid, brown, guttulate, epispore verrucose, 14–18 × 9.5–12 μ.

Under *Quercus agrifolia*. San Mateo County, California. March.

The type material of *Dendrogaster major* is in a preservative and overgrown by a Phycomycete, the large hyphae of which have penetrated the peridium and portions of the septa of the large fructification.

CALIFORNIA: San Mateo County, Palo Alto, on Jasper Ridge near Stanford University, *James McMurphy 281*, type (Stanford, Zeller, and Dodge).

### 2. DENDROGASTER **megasporus** Zeller & Dodge, sp. nov.

Fructificationes 1–2 cm. diametro metientes, griseae vel sordide brunnescentes; columella parce ramosa; peridium 250–350 μ crassitudine, laxe fibrosum recens, 35–85 μ siccatum, prosenchymaticum vel stuposum; gleba "pale tan" vel lutescens brunnescensque, "cinnamon-brown" vel "mummy-brown" siccata, locellis magnis;

septa 30–35 μ crassitudine, stuposa; basidia 1–2-spora, hyalina, clavata vel cylindrica, 20–25 × 7–8 μ; sporae obscure brunneae, obovoideae vel subcitriformes, 20–25 × 11–16.5 μ; episporio leviter rugosa.

Type: in Univ. Cal. Herb.

Fructifications 1–2 cm. in diameter, from a scant mycelium, becoming gray or dirty brown at maturity; columella slightly branched, extending from one-half to two-thirds of the distance through the gleba; peridium 250–350 μ thick, loosely fibrous when fresh, drying 35–85 μ, closely stupose to almost prosenchymatous; gleba pale tan or yellowish, becoming brown, drying cinnamon-brown to mummy-brown, cavities large, shrinking greatly on drying; septa 30–35 μ thick, stupose; basidia 1–2-spored, hyaline, clavate to cylindrical, 7–8 × 20–25 μ; spores dark brown, obovoid to slightly citriform, 20–25 × 11–16.5 μ, epispore slightly wrinkled.

In soil under *Quercus* and *Laurus*. California. January.

CALIFORNIA: Santa Clara County, Saratoga, *H. E. Parks 967, 977* type (Univ. Cal.).

3. DENDROGASTER CAMBODGENSIS Patouillard, Bull. Soc. Myc. France **39**: 55–56. 1923.

Illustrations: Patouillard, Bull. Soc. Myc. France **39**: 56. *f. 1.*

Type: in Patouillard Herb. at Farlow Herb.

Fructifications subglobose to ovoid, citrine-yellow or ochraceous, 1–3 cm. in diameter, rounded above, depressed and concave below, with a slight tubercle-like sterile base in the center of the depression; sterile base yellow, firm, small; peridium thin, minutely furfuraceous, caused by simple groups of cylindrical, yellow hyphae, 25–60 × 4–6 μ; columella arising from the sterile base, irregular, more or less branched, grayish, somewhat gelatinous; gleba chocolate-color, cavities 100–250 ×100 μ, radiating from the columella to the periphery, separated by narrow septa; basidia mostly 2-spored, 18–25 μ long; spores ochraceous-brownish, ovoid, attenuate in a short beak toward the summit, rounded at the base, 9–12 × 6–7 μ, very finely verrucose and surrounded by a very closely fitting utricle which often becomes ragged at maturity, with a large oil globule, often appendiculate.

Cambodia.

The citrine color of the fungus is due to a resinous matter which dissolves in alcohol; and the surface becomes brown.

CAMBODIA: Kompong Chnang, *M. Petelot*, type (Patouillard Herb. at Farlow).

4. DENDROGASTER **candidus** (Harkness) Zeller & Dodge, comb. nov.

*Hymenogaster candidus* Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**: 247. 1899; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 253. 1902.

Type: cotype in Dudley Herb. at Stanford.

Fructifications not over 2 cm. in diameter, white, becoming ferruginous in alcohol; sterile base prominent, columella very reduced; peridium flaking off, leaving only a few patches, the portion left being pseudoparenchymatous, thin; gleba ferruginous, cavities comparatively large, empty; septa 250–275 μ thick, composed of compactly interwoven branched hyphae; paraphyses clavate, 25–30 × 4–6 μ; basidia clavate, 45–60 × 7–8 μ, projecting beyond the paraphyses, sterigmata 4–5 μ long; spores ellipsoid, minutely striate-verrucose, with a closely applied utricle, 10–13.5 × 7–9 μ, 1-guttulate.

Under *Pseudotsuga*. California. May.

CALIFORNIA: Placer County, Towle, *H. W. Harkness 49*, cotype (Stanford).

5. DENDROGASTER **radiatus** (Lloyd) Zeller & Dodge, comb. nov.

*Hymenogaster radiatus* Lloyd, Myc. Notes 73: 1304. 1925; Verwoerd, S. Afr. Jour. Sci. **22**: 166. 1925.

Illustrations: Lloyd, Myc. Notes 73: *f. 2908–2909*.

Type: in Lloyd Museum and in Union of South Africa, Dept. Agr. Myc. Herb.

Fructifications 1–2.5 cm. in diameter, subglobose, rubbery-tough, surface smooth, dirty white, drying rugulose, chamois to fawn-color; peridium simple, of homogeneous hyaline pseudoparenchyma of large vesiculose cells, tough, easily separable and distinct from the gleba, 185–260 μ thick; gleba gelified, rubbery, drying avellaneous to wood-brown, hard, flinty, opalescent because of the gelified septa which radiate from the head (?) of a capitate columella; septa opalescent, of very fine interwoven hyphae immersed in a gel, distinct from the peridium, 35–100 μ thick; basidia not seen; spores sessile, broadly ellipsoid, broadly truncate below, finely verrucose (coarsely above), covered by a gelified sheath (utricle?), 12.5–15 × 8–10 μ, pinkish.

Hypogeous in leaf-mould at foot of trees. Rhodesia, South Africa. March.

UNION OF SOUTH AFRICA: S. Rhodesia, Salisbury, *F. Eyles 2530,* type (Lloyd Mus. 30493, and Union of S. Africa, Dept. Agr. Myc. Herb. 17795).

6. DENDROGASTER CONNECTENS Bucholtz, Hedwigia **40**: 316–318. 1901; Материалы къ морфологіи и систематикѣ подземныхъ грибовъ ... Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. **1**: 148-151. 1902 [often cited as Beitr. Morph. Syst. Hypog.]; Sacc. & D. Sacc. in Sacc. Syll. Fung. **17**: 241. 1905.

Illustrations: Bucholtz, *l. c. pl. 3, f. 15–16.*

Type: portion in Patouillard Herb. at Farlow Herb., and in Berlin.

Fructifications globose, the size of a filbert, rufous; peridium thin, composed of loosely stretched and woven hyphae, more closely woven next the gleba; sterile base present, columella branching, dendroid; gleba light ochraceous-brown; septa composed of slender hyphae sometimes more highly refractive and irregular in the middle; basidia 2-spored, not projecting much beyond the paraphyses, long sterigmata; spores brownish-rufous, oblong-ellipsoid, smooth, with irregular, wrinkled, saccate utricle, short-appendiculate, short-apiculate, 20 × 10.7 μ.

Mikhailovskoe, near Moscow, Russia. August.

The young spores of this species are very similar in shape and markings to those of *Hymenogaster olivaceus.*

U. S. S. R. [RUSSIA]: Moskva, Mikhailovskoe, *F. Bucholtz,* Aug. 14, 1899, type (Farlow and Berlin).

7. DENDROGASTER **utriculatus** (Harkness) Zeller & Dodge, comb. nov.

*Hymenogaster utriculatus* Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**: 246. 1899; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 254. 1902.

Illustrations: Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**: *pl. 42, f. 6a–6f;* Rev. Myc. **22**: *pl. 204, f. 1–5.*

Type: cotype in Dudley Herb. at Stanford.

Fructifications large, irregular, white when fresh, becoming chocolate-brown, enveloped in white mycelium, sterile base slight; columella dendroid, reaching the middle of the fructification; peridium 220–240 µ thick, the outer portion brownish, shading to white within, composed of gelified, parallel hyphae; gleba marbled brown and white when fresh, becoming chocolate-brown, cavities partially filled with spores radiating from the columella; septa 70–80 µ thick between hymenial layers, composed of gelified hyphae; basidia broadly clavate, 25–30 × 7–8 µ, sterigmata 3 µ long; spores ellipsoid to obovoid, smooth, lemon-yellow, enclosed in a utricle which shrinks, appearing alveolate at times, but very irregular, 10–13.5 × 6–7.5 µ (without utricle).

Under *Sequoia, Quercus,* and *Eucalyptus.* California. December to February.

Part of *Harkness 244* is *Hydnangium* sp.

CALIFORNIA: Alameda County, Berkeley, *N. L. Gardner 68, 230* (Univ. Cal. and Zeller); Marin County, Mill Valley, *H. W. Harkness 244* in part, cotype (Stanford); Muir Woods, *H. E. Parks 1165, C. W. Dodge* (Univ. Cal., Dodge, and Zeller); Santa Clara County, Aldercroft Creek, near Los Gatos, *H. E. Parks 1162, 1163, C. W. Dodge 2126* (Dodge and Zeller); Saratoga, *H. E. Parks 1128* (Univ. Cal.).

8. DENDROGASTER **globosus** (Harkness) Zeller & Dodge, comb. nov.

*Hymenogaster globosus* Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**: 246. 1899; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 255. 1902.

Type: cotype in Dudley Herb. at Stanford.

Fructifications small, globose, 0.6–0.9 cm. in diameter, dirty white, becoming brownish; sterile base broadly conical; columella erect, stout to the center of the fructification, branches radiating in all directions from head of columella; peridium variable, 80–140 μ thick, composed of pseudoparenchyma of hyaline cells up to 10 μ in diameter; gleba fuscous to cinnamon, cavities filled with spores; septa composed of medium-sized gelified hyphae, 20–40 μ between hymenial layers; basidia so gelified in type that structure not certain; spores ellipsoid, finely verrucose, surrounded by a loose utricle, 8–11 × 5–6 μ without utricle, light brown.

In damp ground. California. July.

*Harkness 245* without locality, determined as this species, has the outer portion of the peridium brown, the inner portion nearly hyaline; basidia linear to narrowly clavate, inconspicuous, with rather large sterigmata.

CALIFORNIA: *H. W. Harkness 245;* Marin County, Mill Valley, *H. W. Harkness 246,* cotype (both Stanford).

9. DENDROGASTER **foetidus** (Coker & Couch) Zeller & Dodge, comb. nov.

*Hymenogaster foetidus* Coker & Couch, Gasteromycetes Eastern U. S. & Canada, 45–47. 1928.

Illustrations: Coker & Couch, Gasteromycetes Eastern U. S. & Canada, *pl. 17, 18, 110.*

Type: in Univ. N. Car. Herb.

Fructifications 0.7 cm. in diameter or less, spherical, white at first, becoming light ochraceous-buff on drying; radiating mycelium at base with pale ochraceous fibres, 1 cm. or more long; columella reaching the center of the fructification, ending in an irregular head, cartilaginous, at least shrinking on preservation in alcohol; peridium simple, appearing duplex by the outgrowth of mycelial threads which bind humus particles to the surface, simulating patches, true peridium 100–175 μ thick (usually 100–130 μ), composed of olivaceous-yellow, thick, rough-walled hyphae 5–7 μ in diameter; gleba brownish-olive, cavities irregular, partially filled; septa 45–60 μ thick, composed of thin-walled, slender, closely woven, hyaline hyphae; basidia pyriform, 4 spored, 7 × 25 μ, sterigmata short; spores smooth, ovoid to ellipsoid, surrounded by a gelified, saccate sheath, 10.5–11 × 6–7 μ.

Under *Abies* and *Fagus*. Tennessee and North Carolina. Summer.

NORTH CAROLINA: Old Hillsboro Road, 4 miles from Chapel Hill, *J. N. Couch*, type (Univ. N. Car. 7467).

TENNESSEE: Burbank, *R. Thaxter B1H* (Farlow).

## GAUTIERIA

*Gautieria* Vittadini, Monogr. Tuberac. 25–27. 1831; Tulasne, Fung. Hypog. 62–63. 1851; Zobel in Corda, Icones Fung. **6**: 33–34. 1854; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 873–874. 1883; DeToni in Sacc. Syll. Fung. **7**: 177–179. 1888; Hesse, Hypog. Deutschl. **1**: 105–110. 1891.

*Gautiera* Endlicher, Gen. Pl. 30. 1836; Corda, Anleit. z. Stud. Myc. 114. 1842; Icones Fung. **5**: 28. 1842; Rabenhorst, Deutschl. Krypt.-Fl. **1**: 252. 1844; Fries, Summa Veg. Scand. 435. 1849.—*not Gautiera* Rafinesque, Med. Fl. **1**: 202. 1828.

*Chamonixia* Rolland, Soc. Myc. France Bull. **15**: 76. 1899.

The type species of the genus is *Gautieria morchelliformis* Vittadini.

Fructifications spherical to somewhat irregular or flattened, with a simple or branched rhizomorph sometimes persisting as a short stipe; columella variable in size and shape, often branching at the base; peridium thin, fugacious or persistent, in some species scarcely more than sterile outer septa but well differentiated in others; gleba white at first, becoming colored by the masses of spores, cavities variable in size, often elongated, labyrinthiform; septa homogeneous, composed of closely interwoven hyphae; basidia clavate, usually 2–3-spored, with long sterigmata; spores lanceolate, fusiform, ellipsoidal (rarely citriform), with longitudinal striae usually highly developed on the epispore.

### KEY TO SPECIES OF GAUTIERIA

1. Peridium early evanescent or lacking.............................. 2
1. Peridium persistent.............................................. 12
    2. Spores averaging 15 $\mu$ or more long............................ 3
    2. Spores averaging less than 15 $\mu$ long.......................... 9
3. Gleba slate-colored; septa about 300 $\mu$ thick, opalescent....*G. plumbea* (p. 694)
3. Gleba some shade of brown; septa mostly less than 300 $\mu$ thick, whitish.... 4

4. Spores narrowly lanceolate or fusiform, 18–27 × 7–10 μ . . *G. chilensis* (p. 694)
4. Spores ellipsoid, ovoid, or obovoid, diameter more than ½ the length . . . 5
5. Cystidia numerous and prominent . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6
5. Cystidia not numerous and prominent, if present only in upper cavities . . . . 7
6. Spores obovoid, 18–19 × 11–12 μ, with 7–10 almost smooth striations . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. graveolens* (p. 695)
6. Spores ellipsoid, 16–21 × 8–10 μ, with 5–9 rather warted striations . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. gautierioides* (p. 697)
7. Stipe short or absent, spores ellipsoid to obovoid with 8 slightly warted striae, 15–18 × 9–11 μ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. retirugosa* (p. 697)
7. Stipe rather well developed . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8
8. Spores narrowly ellipsoid or obovoid, with 6–8 slightly warted and branched striae, 13–17.6 × 7–10 μ; septa 200–300 μ thick . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. caudata* (p. 698)
8. Spores broadly ellipsoid, with 8–10 rather sinuous striae, 12–24 × 8–12.5 μ; septa about 75 μ thick . . . . . . . . . . . . . . . . . . . . *G. morchelliformis* (p. 698)
8. Spores ellipsoid, with 8–9 striae with conical warts, 12–18 × 8–10 μ; septa 225–275 μ thick . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. Trabuti* (p. 700)
9. Gleba slate-colored; septa about 300 μ thick . . . . . . . . . . . . *G. plumbea* (p. 694)
9. Gleba brown; septa mostly less than 300 μ thick . . . . . . . . . . . . . . . . . . . . . 10
10. Spores averaging less than 12 μ long, ellipsoid to obovoid, with 7–10 slightly warted striae; septa 120–400 μ thick . . . . . . . . *G. monticola* (p. 700)
10. Spores averaging more than 12 μ long . . . . . . . . . . . . . . . . . . . . . . . . . . . 11
11. Spores 12–18 × 8–10 μ, ellipsoid, with 8–9 striae with conical warts; septa 225–275 μ thick . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. Trabuti* (p. 700)
11. Spores 11–15 × 7–8 μ, with 8–10 sinuous, rather warted striae; septa about 150 μ thick . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. mexicana* (p. 701)
11. Spores 12–16 × 6–8 μ, with 10 smooth striae, septa about 90–180 μ thick . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. graveolens* var. *Otthii* (p. 696)
12. Peridium very thin, early evanescent, cystidia prominent . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. graveolens* (p. 695)
12. Peridium thick, persistent, cystidia not prominent . . . . . . . . . . . . . . . . . . 13
13. Peridium distinctly duplex . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 14
13. Peridium distinctly simplex . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15
14. Spores lanceolate, narrowly ellipsoid or obovoid, striae smooth, branched or anastomosing, 17–21 × 7–11 μ . . . . . . . . . . . . . . . . . . . *G. Rodwayi* (p. 702)
14. Spores ovoid or ellipsoid, striae smooth, 12–14 × 7–8 μ . . *G. pallida* (p. 702)
15. Spores with 4 (sometimes 5) striae as viewed from the end, 15–17 × 8–10 μ . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. mucosa* (p. 703)
15. Spores with 6 or more striae, as viewed from the end . . . . . . . . . . . . . . . . . . . 16
16. Spores averaging less than 12 μ long . . . . . . . . . . . . . . . *G. monticola* (p. 700)
16. Spores averaging more than 12 μ long . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 17
17. Spores broadly ellipsoid, 19–21 × 11–15 μ, with 6–10 slightly warted striae . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *G. albida* (p. 704)
17. Spores narrowly ellipsoid or obovoid, 12–20 × 7–10 μ, with 8–10 smooth striae; septa 200–300 μ thick; peridium 600 μ thick . . . . . *G. Harknessii* (p. 704)
17. Spores ovoid-ellipsoid, 14–19 × 7–11 μ, with 9–11 smooth striae; septa 65–100 μ thick; peridium 240–420 μ thick . . . . . . . . . . . . . *G. Parksiana* (p. 705)

1. GAUTIERIA PLUMBEA Zeller & Dodge, Ann. Mo. Bot. Gard. 5: 138–139. 1918.

Illustrations: Ann. Mo. Bot. Gard. 5: *pl. 9, f. 4.*

Type: in Weir, Dodge, and Zeller Herbaria.

Fructifications ovoid, 4 cm. in diameter, cordate, surface convoluted, light brownish-olive to mummy-brown; stipe 2 mm. thick; columella branched, percurrent, gelified; gleba plumbeous-black, slate-color in preservative, drying fuscous-black, gelified, cavities irregular, mostly radiating from the columella, empty; septa about 300 μ thick, composed of highly gelified, hyaline hyphae; subhymenial layer pseudoparenchymatous, of large angular cells; cystidia large, 52–61 × 25–35 μ, hyaline, guttulate, obovoid, often somewhat apiculate; paraphyses narrowly clavate, hyaline, guttulate, septate, 4–5 μ in diameter, some knobbed at the tip, some filiform; basidia hyaline, clavate, 20–26 × 9–10 μ, 1–4-spored, sterigmata less than half the length of the spores; spores 11–16 × 6.5–8 μ, short-pedicellate, English red to burnt sienna, striae 7–10, wavy, young spores ovoid to ellipsoid, smooth, becoming striate.

Under conifers. British Columbia and Idaho. September to October.

BRITISH COLUMBIA: Quartz Creek above Beavermouth, *C. W. Dodge 1536* (Dodge).

IDAHO: Priest River, *J. R. Weir,* type (Weir, Zeller 1458, and Dodge 859).

2. GAUTIERIA **chilensis** Zeller & Dodge, sp. nov.

Fructificationes pyriformes, 1–2 cm. diametro metientes, obscure brunneae; columella dendroidea; peridium non visum; gleba compacta, ochracea; septa albida, 40–50 μ crassitudine, tramate prosenchymatico stratis subhymenialibus pseudoparenchymaticis; basidia clavata vel cylindrica, 2–4-spora; sporae fusiformes vel anguste obovoideae, lanceolatae immaturitate, 6–8 striis longitudinalibus subirregularibus verrucosis, 18–27 × 7–10 μ.

Type: in Farlow Herb. at Harvard University.

Fructifications pyriform, 1–2 cm. in diameter, dark brown; columella dendroid; peridium not present in specimen examined; gleba firm, dense, ochraceous; septa white, 40–50 μ thick, of a central plate of prosenchyma with pseudoparenchymatous subhymenial layers; basidia clavate to cylindrical, 2–4-spored;

spores fusiform to narrowly obovoid, young spores lanceolate, 18–27 × 7–10 μ, with 6–8 longitudinal ribs somewhat irregular and warted.

Chile. February and March.

CHILE: Magellanes, Punta Arenas, *R. Thaxter F. H. 14*, type (Farlow).

3. GAUTIERIA GRAVEOLENS Vittadini, Monogr. Tuberac. 27. 1831; Tulasne, Fung. Hypog. 63. 1851; Corda, Icones Fung. **6**: 34. 1854; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. **1**: 873–874. 1883; Quélet, Ench. Fung. 250. 1886; DeToni in Sacc. Syll. Fung. **7**: 178. 1888; Hesse, Hypog. Deutschl. **1**: 106–108. 1891; Bucholtz, Материалы къ морфологiи и систематикѣ подземныхъ грибовъ ... Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. **1**: 146. 1902 [often cited as Beitr. Morph. Syst. Hypog.].

Illustrations: Bucholtz, *l. c. pl. 3, f. 14; pl. 4, f. 21;* Corda, Icones Fung. **6**: *pl. 7, f. 63;* Fitzpatrick, Ann. Myc. **11**: *pl. 4, f. 11; pl. 7, f. 30–37;* Hesse, Hypog. Deutschl. **1**: *pl. 2, f. 5–9; pl. 7, f. 4–6;* Vittadini, Monogr. Tuberac. *pl. 4, f. 3.*

Type: in Saccardo Herb. at Padua, also in Tulasne Herb. in Paris.

Fructifications spherical, 1–2 cm. in diameter, light ochraceous-buff to Prout's brown; stipe slender and fragile, up to 1 cm. long, 1 mm. thick; columella frequently reaching the center of the fructification, fruticose; odor very strong, as of decaying onions; peridium thin, composed of delicate, thin-walled, loosely woven hyphae, soon rupturing and disappearing; gleba ochraceous-tawny to cinnamon-brown, cavities spherical or elongated, minute, empty; septa 40–80 μ thick, composed of small hyphae, compact; cystidia clavate to subfusiform, hyaline, often obscured by the spores; paraphyses linear, septate; basidia broadly clavate, 2-spored, 12–16 × 8–9 μ, with long, filiform sterigmata; spores ochraceous-tawny, apex rounded, mostly obovoid, pedicellate, 18–19 × 11–12 μ, often with a large oil globule, usually with 7–10 prominent, smooth striae.

Deeply buried under leaf mould. Europe and North America.

EXSICCATI: Saccardo, D., Mycoth. Ital., 427; de Thümen, Mycoth. Univ., 12.

CZECHOSLOVAKIA: Vysoky, Chluniec ad Selcany, *F. Bubak* (Lloyd Mus. 05859).

AUSTRIA: Tyrol, Cavelonte, *G. Bresadola*, in D. Sacc., Mycoth. Ital., 427.

GERMANY: Sachsen, Eisleben, *J. Kunze* (Lloyd Mus. 05916, and Mo. Bot. Gard. 5637); G. Winter in de Thümen, Mycoth. Univ., 12 (ex herb. Fuckel, Farlow, Lloyd Mus., Mo. Bot. Gard., etc.); Bayern, Erharting, *E. Soehner 866* (Soehner).

SWEDEN: Uppland, Flottsund i granskog, *Th. C. E. Fries*, July 20, 1902; Granebergskog, *Th. M. Fries*, Aug., 1904; Elfkarleby Laxön, *A. Zathelius*, Aug., 1891 (all in Upsala).

FRANCE: Alpes Maritimes, *Claus G. Poirault* (Paris).

ITALY: Piemonte, *C. Vittadini* (Paris).

NEW YORK: Ithaca, *H. M. Fitzpatrick* (N. Y. Coll. Agr. Cornell Univ. 8450, Zeller 1535).

MICHIGAN: Isle Royale, Rock Harbor, *C. A. Brown Fp. 301*, *C. A. Brown & A. H. Povah 289* (both Univ. Mich. and Zeller).

3a. var. **Otthii** (Trog) Zeller & Dodge, comb. nov.

*Gautieria Otthii* Trog, Naturforsch. Ges. Bern Mitt. **1857:** 43. 1857 (in Nos. 388–390) [sometimes cited as Verzeichnis Schweiz. Schwämme Nachtrag **3:** 43. 1857]; Sacc. & Sydow in Sacc. Syll. Fung. **14:** 268. 1899; Zeller & Dodge, Ann. Mo. Bot. Gard. **5:** 141. 1918.

Type: in Trog Herb. at the Bot. Inst. Bern.

Fructifications depressed-globose, up to 3 cm. in diameter when fresh, drying 1 × 2 cm., cinnamon to Sayal brown or tawny-olive when dry; stipe 2 mm. in diameter, broken off short in specimen available; columella unbranched, reaching at least one-third the height of the fructification (specimen insect-eaten at the upper portion of the columella); odor weak, unpleasant; peridium not seen; gleba cinnamon to Sayal brown, cavities labyrinthiform, empty, minute; septa 90–180 $\mu$ thick, composed of slender, highly gelified hyphae; basidia clavate, 10–14 × 6–8 $\mu$, sterigmata short, 4-spored; spores ochraceous-tawny, apex rounded, short-pedicellate, 12–16 × 6–8 $\mu$, with about 10 smooth striations.

Switzerland. June.

Differs from *G. graveolens* in narrower spores and unbranched columella. It may be only an immature specimen of *G. graveolens,* as in that species the immature spores are somewhat longer and narrower than mature spores.

SWITZERLAND: Hardlisberg, *G. Otth*, type (in Trog Herb. at Bot. Inst. Bern).

4. GAUTIERIA **gautierioides** (Lloyd) Zeller & Dodge, comb. nov.

*Hymenogaster Trabuti* Zeller & Dodge, Ann. Mo. Bot. Gard. 5: 137–138. 1918.

*Hymenogaster gautierioides* Lloyd, Myc. Notes **7**: 1117. 1922.

Type: in Univ. Cal. Herb. 493, Dodge Herb. 858, and Zeller Herb. 1455.

Fructifications subspherical, about 3 cm. in diameter, surface convoluted, Verona brown in preserved material; stipe slightly developed, arising from very fine, brown rhizomorphs composed of septate hyphae with prominent clamp connections; columella dendroid; peridium composed of loosely woven, large, septate hyphae with swollen cells, soon evanescent; gleba Brussels brown, cavities irregular, empty; septa hyaline, 180–240 μ thick, composed of a pseudoparenchyma of large, subspherical to polyhedral cells; cystidia subcylindric, thin-walled, 8 μ in diameter; paraphyses filiform, septate, guttulate, 3–4 μ in diameter; basidia hyaline, multi-guttulate, 25–30 × 10–16 μ, obovoid to clavate, mostly 4-spored, sterigmata stout, 5–8 μ long; spores 1–3-guttulate, cinnamon to cinnamon-buff, short-pedicellate, spherical when young, becoming ellipsoid, 16–21 × 8–10 μ, with 5–9 striations usually prominently warted.

Under *Acer, Arbutus, Quercus,* and *Sequoia.* Oregon and California. April to October.

OREGON: Benton County, Corvallis, *S. M. Zeller 2567, 2568* (Zeller).

CALIFORNIA: Santa Clara County, Aldercroft, *H. E. Parks 275, Z251* (Zeller); Call of the Wild, *H. E. Parks 274* (Zeller); Guadaloupe Mines, *H. E. Parks* (com. N. L. Gardner 493) type, *911, 962* (all Univ. Cal., Zeller, and Dodge).

GAUTIERIA RETIRUGOSA Th. M. Fries, Svensk Bot. Tidskr. **3**: 271–272. 1909; Th. C. E. Fries, Ark. f. Bot. **17**$^9$: 18. 1921.

Illustrations: Th. C. E. Fries, Ark. f. Bot. **17**$^9$: *f. 8.*

Type: at Upsala.

Fructifications irregular, 4–5 cm. in diameter, brownish; stipe short or none; fibrils abundant, large, prominent, reddish; columella well developed, forking; peridium absent; gleba brownish, cavities large, angled or elongated, irregular, 0.5–1.5

mm. broad, empty; septa thin, 90–120 μ thick, composed of loosely woven, slender hyphae; basidia cylindrical, 2-spored; spores 15–18 × 9–11 μ, ellipsoid to obovoid with 8 striae which are less regular, being sinuous and slightly warted.

Under moss in coniferous forest. Sweden. July and August.

SWEDEN: Gotland, Vallstena, Alvenparken, *T. Vestergren,* Aug., 1897, type; Uppland, Flattsund, *Th. C. E. Fries,* July 20, 1902, *Elias Aug. Fries,* July 20, 1905 (all Upsala).

5. GAUTIERIA **caudata** (Harkness) Zeller & Dodge, comb. nov.

*Hymenogaster caudatus* Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 248. 1899.

Type: cotype in Dudley Herb. at Stanford.

Fructifications subspherical, roughly convoluted, up to 5 cm. in diameter, fuscous, blackish-brown in preservative, cordate, base fleshy, with a caudal appendage 1–2 cm. long and 2 mm. thick, leading from rhizomorphs; columella nearly percurrent, 2 mm. in diameter, narrow, with plate-like branches; peridium formed by gelification of what would otherwise be the hymenial layer of the external septa; gleba Benzo brown to fuscous (dry after preservative), cavities irregular, empty; septa white, broader than the cavities, 200–300 μ thick, of gelified, compact prosenchyma and rather indistinct cylindric basidia, with 2 sterigmata as long as the spores; spores narrowly ellipsoid or obovoid, 13–17.6 × 7–10 μ, pedicellate, russet, with 6–8 slightly warted, somewhat branched striations often with a spiral tendency.

Under *Sequoia* and *Quercus,* California. March to April.

The type collection consists of 3½ specimens, the largest being 24 × 32 × 37 mm. in preservative.

CALIFORNIA: Marin County, Mill Valley, *H. W. Harkness 240* cotype (Stanford); Saratoga, Boy's Outing Farm, *H. E. Parks 969;* Santa Cruz County, Brookdale, *H. E. Parks 2162* (both Univ. Cal.).

6. GAUTIERIA MORCHELLIFORMIS Vittadini, Monogr. Tuberac. 26. 1831; Tulasne, Fung. Hypog. 62. 1851; Corda, Icones Fung. 6: 34. 1854; Winter in Rabenhorst, Krypt.-Fl. Deutschl.

ed. 2. **1**: 873. 1883; DeToni in Sacc. Syll. Fung. **7**: 177–178. 1888; Hesse, Hypog. Deutschl. **1**: 109–110. 1891; Bucholtz, Материалы къ морфологіи и систематикѣ подземныхъ грибовъ . . . Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ с. Михайловскомъ Московской Губ. **1**: 147. 1902 [often cited as Beitr. Morph. Syst. Hypog.].

*Gautieria morillaeformis* Quélet, Ench. Fung. 250. 1886.

*Gautieria villosa* Quélet, Bull. Soc. Bot. France **25**: 290. 1878 [often cited as Champ. Jura Vosges Suppl. **6**: 290. 1878]; Ench. Fung. 250. 1886; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2, **1**: 873. 1883; DeToni in Sacc. Syll. Fung. **7**: 178. 1888.

Illustrations: Bucholtz, *l. c. pl. 3, f. 14;* Corda, Icones Fung. **6**: *pl. 7, f. 62;* Bail. in Nees v. Esenbeck, Th. F. L. & A. Henry, Syst. d. Pilze **2**: *pl. 27, f. 1–4;* Vittadini, Monogr. Tuberac. *pl. 3, f. 6.*

Type: location unknown to us but abundant material from Vittadini in Tulasne Herb. in Paris.

Fructifications spherical to oblong, 1–3 cm. in diameter, with a basal stalk-like, usually much-branched rhizomorph; columella rudimentary, merely a subspherical summit of the rhizomorph, from which rather thick septal plates radiate into the gleba; peridium thin in the early stages, soon evanescent; gleba ochraceous-tawny to hazel, cavities 1–6 mm. in diameter, subspherical to irregular, mostly radiating from the base; septa white when broken, stupose, about 75 μ thick; basidia about as large as the spores, hyaline, granular, 2–3-spored, sterigmata filiform, as long as the spores; cystidia in the upper cavities of the fructification, not prominent; paraphyses clavate, septate, hyaline; spores 12–24 × 8–12.5 μ, pedicellate, 1–2-guttulate, with 8–10 rather sinuous striae.

In clay soil, under hardwood trees and shrubs. Europe and United States. Spring, summer, and autumn.

EXSICCATI: Roumeguère, Fung. Gall. Exsicc., 2218, under the name *G. villosa.*

CZECHOSLOVAKIA: Tabor, *F. Bubak* (Lloyd Mus. 05860).

AUSTRIA: Tyrol, near Magras, *G. Bresadola,* in Roumeguère, Fung. Gall. Exsicc., 2218 (N. Y. Bot. Gard.); without locality, *G. Bresadola,* Aug., 1881, Oct., 1882 (Upsala).

FRANCE: Jura, Lepinay, *N. Patouillard,* Aug. 16 (Farlow and Lloyd Mus. 08–53); Alpes Maritimes, 1500 m., *Claus G. Poirault* (Paris); Vosges and Jura, *L. Quélet* (Cooke Herb. at Kew appearing typical but not sectioned); Doubs, Hérimoncourt, *L. Quélet,* type of *G. villosa* (Upsala).

SWITZERLAND: Bern, Faulenseewald, *Trog* (Bot. Inst. Univ. Bern).

ITALY: Trentino, Milano, *C. Vittadini* (Paris and Kew).

NEW YORK: Washington County, Hudson Falls, *S. H. Burnham* (Dodge and Zeller).

OREGON: Benton County, Corvallis, *S. M. Zeller 1969;* Hood River County, near Parkdale, *S. M. Zeller 8209* (both Zeller).

CALIFORNIA: Mariposa County, Big Tree Grove, *H. W. Harkness 113,* in part (Stanford); Santa Clara County, Guadaloupe Mines, *H. E. Parks 314, 903* (Zeller); near San Jose, *H. E. Parks* (com. N. L. Gardner 541, Zeller); Saratoga, *H. E. Parks* (Zeller 1646); Los Angeles County, Claremont, *Lois M. Clency* (com. C. G. Lloyd, Pomona Coll., Lloyd Mus. 1759, Zeller 1532).

7. **GAUTIERIA TRABUTI** (Chatin) Patouillard, Bull. Soc. Myc. France **13**: 203–204. 1897.

*Hymenogaster Trabuti* Chatin, Bull. Soc. Bot. France **38**: 64. 1891.

Illustrations: Patouillard, Bull. Soc. Myc. France **13**: *pl. 13, f. 2.*

Type: in Dodge and Zeller Herbaria, com. Mattirolo, and Patouillard Herb. at Harvard University.

Fructifications 2 cm. in diameter, spherical, convoluted, pale gray-drab in dried material, mummy-brown when moistened; stipe slightly developed, radiciform; peridium evanescent, outer hymenial layer with large spherical cells, 15–25 μ in diameter, scattered over its surface; gleba concolorous; septa hyaline, 225–275 μ, composed of small, gelified, hyaline hyphae; basidia short-clavate, 2-spored; spores ellipsoid, obtuse above, mucronate below, 12–18 × 8–10 μ, with 8–9 longitudinal striae having conical warts, especially toward the distal end.

Algeria, and Jura Mountains, France.

ALGERIA: Sidi abd el Kader, près de Blida, *Trabut,* type (Farlow, Dodge, and Zeller).

FRANCE: Jura septentrionale, montagne du Lomont, *L. Quélet* (Upsala).

8. **GAUTIERIA MONTICOLA** Harkness, Cal. Acad. Sci. Bull. **1**: 30. 1884; De Toni in Sacc. Syll. Fung. **7**: 178–179. 1888.

*Hymenogaster monticolus* Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: 249. 1899.

Type: cotype in Dudley Herb. at Stanford and in N. Y. Bot. Gard. Herb.

Fructifications irregularly lobed, nearly plane above and below, 10 cm. in diameter and about 3 cm. tall, Dresden brown to mummy-brown; sterile base not prominent, columella very slender, branching; peridium or rather the outer portion of the gleba 140–160 μ thick, composed of hyphae with greatly gelified walls enclosing dirt in the outer portion; gleba ochraceous-tawny to grayish-brown, cavities small, empty; septa 120–400 μ thick, hyaline, composed of more or less gelified hyphae parallel with the hymenial surface; basidia arising from erect, septate hyphae 16 × 6–7 μ, ovoid, mostly 2-spored, sterigmata filiform, 7–10 μ long; spores 1–several-guttulate, ochraceous-tawny, ellipsoid to obovoid, 9–13 × 6.5–8 μ, with 7–10 longitudinal or oblique striations, sometimes slightly warted.

On the ground under conifers. California. July.

The cotype, *H. W. Harkness 113,* contains a mixture of two distinct types of fructifications: one with large empty cavities with large spores seems to be *G. morchelliformis;* the other type which has been taken as the type of this species has small cavities and spores.

CALIFORNIA: Mariposa County, Big Meadow, *W. A. Setchell* (Univ. Cal. 542, and Zeller); Big Tree Grove, *H. W. Harkness 113* [*3543*] cotype (Stanford and N. Y. Bot. Gard.); Santa Clara County, Saratoga, *Roland Rice* (com. H. E. Parks 1097, Dodge); Aldercroft, *H. E. Parks 209* (com. N. L. Gardner 544, Zeller).

9. **GAUTIERIA mexicana** (Fischer) Zeller & Dodge, comb. nov.

*Gautieria graveolens?* Chatin, La Truffe, 82–83. 1892.

*Gautieria graveolens* var. *mexicana* Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1**: 305. 1899.

Illustrations: Chatin, La Truffe *pl. 15, f. 4;* Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1**: 304.

Type: exhibited at the exposition in Paris, 1889, exhibits from Mexico, a portion in herb. Chatin in Patouillard Herb. at Harvard Univ.

Fructifications 1–4 cm. in diameter, drying Prout's brown; columella large, penetrating the center of the fructification; peridium absent; gleba ochraceous-tawny, cavities very small;

septa about 150 μ thick, of slender gelified hyphae; spores 11–15 × 7–8 μ, with 8–10 wavy, rather warted striae.

CALIFORNIA: Guadaloupe Mines, *H. E. Parks 986* (Univ. Cal., Dodge, and Zeller). MEXICO: com. Chatin, type (Farlow).

### 10. GAUTIERIA **Rodwayi** (Massee) Zeller & Dodge, comb. nov.

*Hymenogaster Rodwayi* Massee, Kew Bull. Misc. Inf. **1898**: 126. 1898; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 253. 1902; Rodway, Papers & Proc. Roy. Soc. Tasmania **1923**: 153. 1924.

Type: in Kew.

Fructifications 2–3 cm. in diameter, irregular, white, becoming dingy yellow when dry; sterile base a more or less fruticose columella which becomes dark brown at maturity; peridium duplex, the outer 60 μ composed of thick-walled, periclinal hyphae, rather loosely woven, the inner layer similar to the gleba, about 120 μ thick, of large-celled prosenchyma; gleba firm, dark brown, cavities rather minute; septa about 120 μ between hymenia, similar to the inner portion of the peridium but more completely gelified; basidia not seen, but spores in twos; spores lanceolate to narrowly obovoid-ellipsoid, acuminate to acute, the younger spores showing a short apiculus, brown, 17–21 × 7–11 μ; striae 10–12, somewhat irregular, forked and anastomosing, converging at the tip.

Among buried twigs. Tasmania, and New South Wales, Australia.

TASMANIA: *L. Rodway 116*, type (Kew); Mt. Nelson Range, *L. Rodway 1104*; McRobie's Gully, *L. Rodway 1284* (both Dodge and Zeller).

AUSTRALIA: New South Wales, Mt. Wilson, *J. B. Cleland 7*; Ryde, *J. B. Cleland 15* (both Dodge and Zeller).

### 11. GAUTIERIA **pallida** Harkness, sp. nov.

*Hymenogaster pallidus* Harkness, Proc. Cal. Acad. Sci. Bot. III. **1**: 249. 1899; *not* Berkeley & Broome, Ann. & Mag. Nat. Hist. I. **18**: 74. 1846.

Fructificationes ad 1 cm. diametro metientes, irregulariter sphericae, obscure brunneae conservata; basis sterilis pulvinata, columella non visa; peridium duplex, strato extero 160 μ crassitudine, funiculis laxe implexis, strato intero 40 μ crassitudine, hyphis periclinalibus, brunneis, septatis; gleba obscure brunnea, locellis parvis, sinuosis, vacuis; septa 140 μ crassitudine, hyphis tenuibus, gelificatis, dense contextis; basidia clavata, 12–16 × 6–7 μ; sporae ovoideo-ellipsoideae, longitudinaliter striatae, striis sublaevibus, 12–14 × 7–8 μ.

Type: in Dudley Herb. at Stanford.

Fructifications about 1 cm. in diameter, irregularly spherical, very dark brown in alcohol; sterile base pulvinate, but columella not visible; peridium duplex, the outer layer about 160 μ thick, the inner 40 μ, the outer of loosely woven strands of medium thin-walled hyphae with large air spaces, the inner of very dense strands of thick-walled, periclinal, brown, septate hyphae; gleba very dark brown, cavities small, sinuous, empty; septa 140 μ thick, composed of three layers, the inner darker brown, the outer two nearly hyaline, composed of fine, compactly woven, very gelified hyphae; basidia clavate, 12–16 × 6–7 μ, granulate; spores ovoid-ellipsoid, with 10–12 nearly smooth longitudinal striations, 12–14 × 7–8 μ.

CALIFORNIA: Santa Clara County, Saratoga, *H. E. Parks 1003, 1098* (Univ. Cal.); Los Gatos Cañon, *H. E. Parks 53* (Univ. Cal.); Marin County, Camp Taylor, *H. W. Harkness 81*, type (Stanford).

CHINA: Su-tchuen Oriental, Tchen keou tin, 1800 m., *R. P. Fargas 1566* (Farlow).

12. GAUTIERIA **mucosa** (Petri) Zeller & Dodge, comb. nov.

*Hymenogaster mucosus* Petri, Malpighia **14**: 130. 1900; Sacc. & Sydow in Sacc. Syll. Fung. **16**: 253. 1902.

Illustrations: Petri, Malpighia **14**: *pl. 2, f. 11, 13, 14, 16.*

Type: in Ist. Bot. Univ. Firenze.

Fructifications about 3 cm. in diameter, spherical to irregular, dark brown in alcohol, firm, surface felt-like, columella not evident in the slice available for study; peridium 280 μ thick, not separable, of large, swollen, granular hyphae 6–7 μ in diameter, more or less compact and periclinal on the outside, very loosely tangled within, imbedded in a gel; gleba very dark brown, gelified, cavities very small, labyrinthiform, radiating from the base; septa composed of colored, large, thin-walled, septate hyphae similar to the inner portion of the peridium; basidia pyriform, 2-spored, 10 × 11 μ; spores fusiform to ellipsoidal, with 4, rarely 5, striae, appearing square in optical cross-section, appendiculate, 15–17 × 8–10 μ.

Sarawak, Borneo.

The systematic position of this species is still somewhat in doubt, as we have not observed a columella and the peridium does not seem separable. Beccari notes that the cavities appear to radiate from the base. In texture and general appearance and in the shape of the spores, there seems little resemblance to *Hymenogaster*. It is to be hoped that when more material is available from the mountains of Borneo and Java it will throw further light on this problem.

BORNEO: Sarawak, *O. Beccari*, 1867, type (Ist. Bot. Univ. Firenze).

13. GAUTIERIA **albida** (Massee & Rodway) Zeller & Dodge, comb. nov.

*Hymenogaster albidus* Massee & Rodway, Kew Bull. Misc. Inf. **1901**: 158. 1901; Sacc. & D. Sacc. in Sacc. Syll. Fung. **17**: 239. 1905; Rodway, Papers and Proc. Roy. Soc. Tasmania **1923**: 153. 1924.

Type: in Kew and N. Y. Bot. Gard. Herbaria.

Fructifications 1–2 cm. in diameter, irregular, dirty white; sterile base very slight or absent; peridium of densely woven hyphae, homogeneous with the gleba, with an outer layer of loosely tangled, larger hyphae, including particles of soil; gleba pinkish, becoming ochraceous-tawny on drying, cavities tortuous; basidia broadly clavate, 2–4-spored (mostly 2-spored); spores broadly ellipsoid, with 6–10 ribs, somewhat verrucose (3–4 warts per rib), 19–21 × 11–15 μ.

TASMANIA: *L. Rodway 643*, type (Kew and N. Y. Bot. Gard.), *1283* (Dodge and Zeller); Hobart, *L. Rodway 1116, 085* (Lloyd Mus.).

14. GAUTIERIA **Harknessii** Zeller & Dodge, sp. nov.

*Hymenogaster Bulliardi* Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 249. 1899—*not* Vittadini, Monogr. Tuberac. 23. 1831.

Fructificationes 2.5 × 2 × 2 cm. metientes, "Prout's brown" vel "mummy-brown," pyriformes; stipites funiculique non visi; columella fruticosa, ramosa, 1 mm. diametro metiens; peridium 600 μ crassitudine, hyphis brunneis, ramosis, laxe implexis, 3–4 μ diametro, luteis cum crystallis; sub peridio stratum glebae 200 μ crassitudine, hyphis hyalinis tenuibus, dense contextis; gleba "olivaceous-black (1)" conservata, locellis vacuis, parvis; septa 200–300 μ crassitudine, hyphis tenuibus, gelificatis, dense contextis; sterigmata brevia; sporae anguste ellipsoideae vel obovoideae, 12–20 × 7–8 μ, striis 8–10, longitudinalibus, laevibus.

Type: in Dudley Herb. at Stanford.

Fructifications 2.5 × 2 × 2 cm., Prout's brown to mummy-brown, pyriform; stipe and fibrils not seen; columella fruticose, branching, 1 mm. in diameter; peridium 600 μ thick, composed of very loosely woven, branched, brown, thin-walled hyphae 3–4 μ in diameter, occasionally encrusted with yellowish crystals; below the peridium usually a thick layer of glebal tissue 200 μ thick, composed of very slender, hyaline, compactly woven hyphae; gleba olivaceous-black (1) in alcohol, cavities empty, small; septa 200–300 μ thick, composed of slender, hyaline, gelified, closely woven hyphae; sterigmata short; spores narrowly ellipsoid or obovoid, 12–20 × 7–10 μ, longitudinally striate with 8–10 smooth ribs.

OREGON: Linn County, Roaring River Fish Hatchery, *S. M. Zeller 7793* (Zeller).
CALIFORNIA: Marin County, Mt. Tamalpais, *H. W. Harkness 233,* type (Stanford).

15. GAUTIERIA PARKSIANA Zeller & Dodge in Zeller, Mycologia **14**: 196–197. 1922.

Illustrations: Zeller, Mycologia **14**: 197. *f. 5–6.* 1922.

Type: in Zeller Herb. and in Dodge Herb.

Fructifications gregarious, subspherical to irregular, 1–5 cm. in diameter, some specimens drying light ochraceous-buff to ochraceous-tawny, others drying buckthorn-brown to mummy-brown; rhizomorphs white, 1–2 mm. in diameter, usually branching from a distinct radicle; columella branched; peridium persistent, 240–420 μ thick, stupose, of very fine hyphae; gleba pinkish-brown, drying ochraceous-tawny to Dresden brown, cavities 3–4 per mm., empty, spherical to irregular; septa 65–100 μ thick, hyaline, of interwoven hyphae generally extending longitudinally; basidia clavate, arising from the trama obliquely, usually two-spored, 28–38 × 7–10 μ, hyaline, sterigmata 5–14 μ long; spores ovoid-ellipsoid, buckthorn-brown in mass, pale olivaceous under microscope, with 9–11, usually 10, striations, 7–11 × 14–19 μ.

In soil under *Heteromeles, Pseudotsuga,* and *Quercus.* Oregon and California. March to June.

OREGON: Benton County, Corvallis, *S. M. Zeller 1970, 7057* (Zeller).
CALIFORNIA: Santa Clara County, Saratoga, Boy's Outing Farm, *H. E. Parks 441* type, *352, 1004;* Guadaloupe Mines, *H. E. Parks 415 (Z5);* also without locality and one unnumbered specimen, *H. E. Parks 593* (all Univ. Cal.).

## Explanation of Plate

### PLATE 18

Illustrations of spores of *Hymenogaster*, *Richoniella*, *Dendrogaster*, and *Gautieria*. In parenthesis are given briefly the material from which the drawings were made. All drawings are on the same scale (× 500).

Fig. 1. *Hymenogaster albellus* Massee & Rodway (Type, *Rodway 117*).

Fig. 2. *H. albus* (Klotz.) Berkeley & Broome (Type, *J. D. Hooker*).

Fig. 3. *H. arenarius* Tulasne (*Tulasne*, July, 1845).

Fig. 4. *H. atratus* (Rodway) Zeller & Dodge (Type, *Rodway 1265*).

Fig. 5. *H. Boozeri* Zeller & Dodge (Type, *Boozer*, in Zeller 2286).

Fig. 6. *H. Bulliardi* Vitt. (*C. Vittadini*, Milano, Italy).

Fig. 7. *H. caerulescens* Soehner (*Soehner 613*).

Fig. 8. *H. cerebellum* Cavara (Type, *Cavara*, Fung. Longobard., 109).

Fig. 9. *H. citrinus* Vitt. (*C. Vittadini*, Milano, Italy).

Fig. 10. *H. fragilis* Zeller & Dodge (Type, *Thaxter*, Chile).

Fig. 11. *H. fusisporus* (Massee & Rodway) Zeller & Dodge (Type, *Rodway 276*).

Fig. 12. *H. Gardneri* Zeller & Dodge (Type, *Gardner 89*).

Fig. 13. *H. Gilkeyae* Zeller & Dodge (Type, *Parks 983*).

Fig. 14. *H. griseus* Vitt. (*C. Vittadini*, Milano, Italy).

Fig. 15. *H. Hessei* Soehner (Type, *Hesse*, Oct. 6, 1886).

Fig. 16. *H. levisporus* Massee & Rodway (Type, *Rodway 653*).

Fig. 17. *H. lilacinus* Tulasne (Type, *Tulasne*, Oct., 1843).

Fig. 18. *H. luteus* Vitt. (*C. Vittadini*, Milano, Italy).

Fig. 19. *H. lycoperdineus* Vitt. (*C. Vittadini*, Milano, Italy).

Fig. 20. *Gautieria mucosa* (Petri) Zeller & Dodge (Type, *O. Beccari*, Borneo).

Fig. 21. *Hymenogaster mutabilis* (Soehner) Zeller & Dodge (Type, *Soehner 703*).

Fig. 22. *H. muticus* Berkeley & Broome (*Barla*, Nice, France).

Fig. 23. *H. niveus* Vitt. (*C. Vittadini*, Milano, Italy).

Fig. 24. *H. occidentalis* Zeller & Dodge (Type, *Zeller 6814*).

Fig. 25. *H. olivaceus* Vitt. (*C. Vittadini*, Lombardia, Italy).

Fig. 26. *H. Parksii* Zeller & Dodge (Type, *Parks 950*).

Fig. 27. *H. pachydermis* Zeller & Dodge (Type, *J. C. Neill*, Nelson, New Zealand).

Fig. 28. *H. populetorum* Tulasne (Type, *Tulasne*, Oct., 1841).

Fig. 29. *H. pyriformis* Zeller & Dodge (Type, *Parks 2262*).

Fig. 30. *H. Remyi* Zeller & Dodge (Type, *M. Remy*, Briançon, France).

Fig. 31. *H. reticulatus* Zeller & Dodge (Type, *J. B. Cleland 6*, South Australia).

Fig. 32. *H. ruber* Harkness (Cotype, *Harkness 248* ).

Fig. 33. *H. spictensis* Patouillard (*Patouillard*, Jura, France, Oct., 1906).

Fig. 34. *H. sulcatus* Hesse (*R. Hesse*, Stadtwald, Germany, August, 1890).

Fig. 35. *H. tener* Berkeley & Broome (*Tulasne*, Sept., 1844, type of *H. argenteus*).

Fig. 36. *H. Thwaitesii* Berkeley & Broome (Type, *G. H. K. Thwaites*, Portbury, England).

Fig. 37. *H. verrucosus* Bucholtz (Type, *Bucholtz 1283*).

Fig. 38. *H. viscidus* Massee & Rodway (Type, *Rodway 270*, Hobart, Tasmania).

## Explanation of Plate

### PLATE 18 (Continued)

Fig. 39. *H. vulgaris* Tulasne (Type, *Tulasne,* Apr. 17, 1846).

Fig. 40. *H. zeylanicus* Petch (Type, *Petch 4603,* Hakgala, Ceylon).

Fig. 41. *H. McMurphyi* Zeller & Dodge (Type, *McMurphy 292*).

Fig. 42. *Richoniella asterospora* (Coker & Couch ) Zeller & Dodge (Type, *J. N. & Else R. Couch,* Univ. N. Car. Herb. 8271).

Fig. 43. *R. leptoniispora* (Richon) Costantin & Dufour (*M. Paneau,* Verdun, France).

Fig. 44. *Dendrogaster cambodgensis* Patouillard (Type, *M. Petelot,* Cambodia).

Fig. 45. *D. connectens* Bucholtz (Type, *Bucholtz,* Mikhailovskoe, U. S. S. R.).

Fig. 46. *D. foetidus* (Coker & Couch) Zeller & Dodge (Type, *Couch,* Univ. N. Car. Herb. *7467*).

Fig. 47. *D. major* Zeller & Dodge (Type, *J. McMurphy 281*).

Fig. 48. *D. megasporus* Zeller & Dodge (Type, *H. E. Parks 977*).

Fig. 49. *D. radiatus* (Lloyd) Zeller & Dodge (Type, *F. Eyles 2530,* Union S. Africa Dept. Agr. Myc. Herb.).

Fig. 50. *D. utriculatus* (Harkness) Zeller & Dodge (Cotype, *Harkness 244*).

Fig. 51. *Gautieria albida* (Massee & Rodway) Zeller & Dodge (Type, *Rodway 643,* Tasmania).

Fig. 52. *G. caudata* (Harkness) Zeller & Dodge (Cotype, *Harkness 240*).

Fig. 53. *G. gautierioides* (Lloyd) Zeller & Dodge (Type, *H. E. Parks,* Univ. Cal. 493).

Fig. 54. *G. graveolens* Vittadini (Type, *C. Vittadini,* Piemonte, Italy).

Fig. 55. *G. graveolens* var. *Otthii* (Trog) Zeller & Dodge (Type, *G. Otth,* Hardlisberg, Switzerland).

Fig. 56. *G. chilensis* Zeller & Dodge (Type, *Thaxter F. H. 14,* Punta Arenas, Chile).

Fig. 57. *G. mexicana* (Fischer) Zeller & Dodge (Type, *Chatin,* Mexico).

Fig. 58. *G. monticola* Harkness (Cotype, *Harkness 113*).

Fig. 59. *G. morchelliformis* Vittadini (*C. Vittadini,* Milano, Italy).

Fig. 60. *G. pallida* Harkness (Type, *Harkness 81*).

Fig. 61. *G. Parksiana* Zeller & Dodge (Type, *H. E. Parks 441*).

Fig. 62. *G. plumbea* Zeller & Dodge (Type, *J. R. Weir,* Priest River, Id.).

Fig. 63. *G. retirugosa* Th. M. Fries (Type, *T. Vestergren,* Vallstena, Sweden).

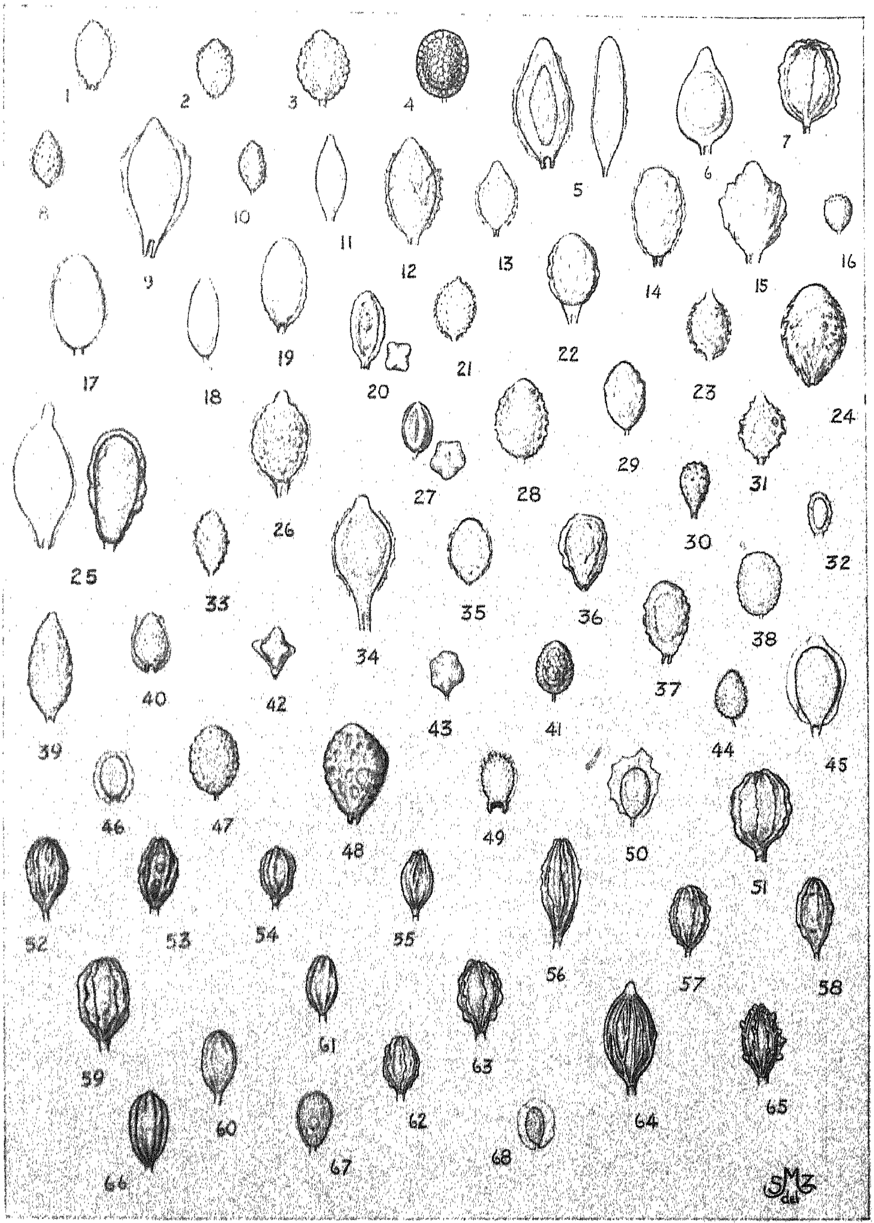
Fig. 64. *G. Rodwayi* (Massee) Zeller & Dodge (Type, *Rodway 116,* Tasmania).

Fig. 65. *G. Trabuti* (Chatin) Patouillard (Type, *Trabut,* Algeria).

Fig. 66. *G. Harknessii* Zeller & Dodge (Type, *Harkness 233*).

Fig. 67. *Dendrogaster candidus* (Harkness) Zeller & Dodge (Cotype, *Harkness 49*).

Fig. 68. *D. globosus* (Harkness) Zeller & Dodge (Cotype, *Harkness 246*).



DODGE AND ZELLER—HYMENOGASTER AND RELATED GENERA

# PROPOSALS FOR AMENDMENT OF ARTICLE 20 OF THE INTERNATIONAL RULES OF NOMENCLATURE

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I. It is moved to strike out "–32" in article 20 (f) so that it will read: (f) Fungi caeteri, 1821 (Fries, *Systema mycologicum*).

Seymour (Host Index of North American Fungi, ix. 1929) and Ramsbottom (Brit. Myc. Soc. Trans. **18**: 314-316. 1934) have called attention to the ambiguity of this section of Article 20 (Article 19 of the Brussels Rules). The writer (Ann. Myc. **27**: 157. 1929) has also called attention to this subject as it affects the standing of *Elaphomyces*. Undoubtedly many others have struggled with the same problem.

This emendation will solve or at least simplify most of the difficulties involved and is in line with much current practice. It seems probable that the framers of this section intended this interpretation and that "–32" was added editorially when it was noted that the last part containing the index to the 'Systema mycologicum' was not published until 1832. Some of those who were very active in framing the rules as they relate to the nomenclature of fungi, including the late W. G. Farlow, always took this view and have largely influenced current practice.

If one takes the alternative interpretation (e. g. Ramsbottom, *l. c.*) that most of the Discomycetes and Tremellaceae begin with 1822 (Fries, Systema mycologicum, vol. 2, part 1), etc., one is faced with the difficulty of deciding whether Persoon's 'Mycologia europaea.' 1822, was published before or after the work of Fries. Mutatis mutandis, the same problem arises in some of the other parts. On the other hand, if 1821 be taken as the point of departure for all the *Fungi caeteri*, this problem is less acute as the only work to be considered is S. F. Gray's 'Natural Arrangement of British Plants.' 1821. Ac-

Issued December 12, 1934.

cording to a note left by the late W. G. Farlow, the mycologists active in framing the rules agreed to consider it subsequent to Fries' 'Systema mycologicum.' 1821, as no information was available at the time (and none has been found since) which would settle the question of priority between these two works.

The decade 1821-1831 was very rich in important publications in the field of mycology. In many groups in which Fries was little interested and on which he published nothing subsequent to his treatment in the 'Systema,' the work of this period is superior to that of Fries. If we accept the interpretation that the date when a genus was treated in Fries' 'Systema mycologicum,' is the date of departure for that genus, we have the anomalous situation that part of an author's work is acceptable as valid, while the work on a closely related genus is invalid, although the whole was published in the same book at the same time; e. g., Gray's treatment of *Geoglossum* in 1821 is valid but not his treatment of *Helvella* and other genera of Discomycetes, although he is more modern in his segregation of genera than was Fries, and in practice some of his generic names are in common use although Fries did not recognize them in 1822. By confining the date to 1821 we conserve the Friesian tradition and interpretation for all groups in which he showed a continuing interest and in which he has profoundly influenced mycology, while allowing the works of Gray (Discomycetes), Persoon and Link (Fungi Imperfecti), who worked with better optical equipment and published figures of microscopic detail in some cases, to be taken directly rather than through the interpretation of Fries, who never used a microscope.

It was the intention of the late A. B. Seymour and of the late Roland Thaxter, both of whom had a wide experience in the nomenclature of most groups of fungi over a period of fifty years, to offer this motion to clarify this ambiguity which was evident soon after the publication of the International Rules of Botanical Nomenclature in 1912. However, pressure of work prevented its submission in time to be placed upon the agenda at the last Congress in Cambridge, 1930, and they died some time before the call for motions for the Congress in Amsterdam in 1935.

II. It is moved to insert the following paragraph at the end of Article 20: It is permissible to recognize the Friesian subgenera ("tribus") of *Agaricus* (Fries, Syst. Myc. 1: 1–314. 1821) as genera, citing only Fries as the author of species so long as they are retained in the genus corresponding to the "tribus" in which Fries placed them.

In the decades from 1870 to 1890, Friesian subgenera of *Agaricus* were all raised to generic rank by Quélet, Karsten, and other authors, quite blindly following the Friesian tradition. In most cases, the authors probably were unconscious that they had introduced an innovation. It is almost impossible to determine who first used a name, owing to the rarity of one work and the ephemeral nature of others. Quélet's 'Champignons du Jura et des Vosges' and its first three supplements were published in the very rare 'Mémoires de la Société d'Émulation de Montbéliard,' of which no copy is known to exist in America and the only set known to me containing these volumes is in the Bibliothèque Nationale de Paris. This work was reprinted, revised, and repaged without clear indication of the dates of issue and is known in only a few of the very large libraries of the world. The other sources for new combinations not made by Quélet, who treats the flora of a very limited region, are scattered through popular mushroom books of the period, often undated or occurring only in later editions in libraries, mostly with unsatisfactory descriptions. Karsten's 'Rysslands, Finlands och den Skandinaviska halföns Hattsvampar' 1: 1–571. 1879, although not maintaining the Friesian tradition, yields other combinations as he dealt with a somewhat different flora. Not until Cuboni & Mancini's compilation in their 'Sylloge Hymenomycetum' 1: 1–1144. 1887 [Saccardo, Syll. Fung. 5] are all the known species of the old genus *Agaricus* referred to their modern subgenera, citing Fries as the author. Since the determination of the date of the combinations produced when the old Friesian subgenera ("tribus") were raised to generic rank involves bibliographic research out of all proportion to the importance of the matter, almost all authors dealing with Agaricaceae have consistently cited Fries only, although in none of his publications did he formally use the combination attributed to him. In much of the literature before 1870, the generic name *Agaricus* was indicated only by its initial while the subgeneric name is practically always written out in full. Even Fries practically regarded his subgenera as genera, e. g., in the individual parts of the 'Monographia,' we find titles as "Monographia Mycenarum," "Monographia Collybiarum," etc., although in the work itself he still retains the A. before the subgeneric name.

Some may suggest that if this is done, it might be done with equal propriety with segregates from other large Friesian genera such as *Hydnum, Polyporus, Peziza, Sphaeria,* etc. The cases are not altogether parallel. Segregates were not so universally recognized, nor named for the Friesian subgenera so completely. They were usually made in formal proposals by authors who realized what they were doing. They are to be found in relatively common books and periodicals where it is usually possible to determine dates with some degree of accuracy, and they were usually made much earlier.

# GENERAL INDEX TO VOLUME XXI

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